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SCIENCE CLASS EXAMINATIONS.

SINCE writing a short article on this subject in the ELECTRICAL REVIEW for May 26th, we have been favoured with a copy of the Technological Examination papers, 1883, of the City and Guilds of London Institute for the advancement of Technical Education. Our former remarks will apply with equal if not with greater force to one of the papers we have now before us, and therefore it is unnecessary for us to go over the same ground again. We will now merely glance at the questions here set without entering generally into the matter of such examinations. In the paper entitled "Electric Lighting and *Transmission of Power*" we find eleven questions arranged for a test of the student's knowledge, but of these it is only necessary that six should be answered, the remainder being attempted at the option of the pupil. Many of our readers will probably be surprised when we state that there is not *one* question concerning the transmission of Power, not *one* question on arc lighting, and only one regarding "what is meant by the efficiency of an incandescent lamp." Two of the questions—we cannot devote the space for reproducing them, but we may as well point them out (2 and 3)—are surely more suited for an ordinary "electricity" examination than as subjects under the title of the paper referred to. We must not forget to mention that this is the "ordinary or pass grade," although we find almost the identical faults in the higher examination paper or "Honours grade." Here we do not see one question on arc lighting, or how to sketch or construct an incandescent lamp, and some of the examples on electro-motors are so long that we would recommend the gentleman responsible for these papers to take a lesson from Prof. Goodeve or Mr. W. H. Preece how best to set concise short questions.

The second set of examination papers we have to speak of are those on "Telegraphy." In both classes we find ten questions, the longest in either paper being confined to about four lines. Both may be classed as good specimens of what such papers should be, including as they do questions on single and double fluid batteries, resistance, conduction, insulation, leakage, submarine cable working, atmospheric electricity, single and double current telegraphing, telephony, railway signalling, duplex telegraphy, and almost every conceivable topic which can be compressed into the space the examiner has allowed himself. In the one case it is possible to conceive that the examiner had set his questions for his own benefit, and in the other we can only see a desire to bring forth the groundwork or base of the pupil's knowledge to his own advantage. We should imagine that the percentage of successful students in "Telegraphy" will be far in excess of those studying "Electric lighting and transmission of power," especially in the "pass" grades, but time will show, and if we find ourselves mistaken we shall be ready to confess our error. Looking at the matter from our present point of view we think that much more discretion should be shown by examiners generally in setting these questions, more especially in subjects which are comparatively new, such as in the paper first mentioned. We have never had much faith in competitive examinations, nor do we believe that the men who come out best in these examinations are possessed of the greatest and most useful talent—there are many circumstances which go to prove the contrary; and as we have before said, the object of such examinations is apparently to find out that which a man does not know, and not to ascertain whether he is possessed of such sound and useful knowledge as may pre-eminently fit him for the work of which he intends to make a profession and for which, from nervousness or other cause, an examination would apparently make him appear to be unfit.

THE ELECTRIC LIGHT IN THE HOME.*

By J. MUNRO, C.E.

THE electric light, whatever its demerits in its present stage, and in spite of some public apathy just now to its advantages, is obviously our future artificial light-in-chief. It is our nearest approach to an ideal light, that is to say, a light pure and simple, free from burning and the decomposition of chemical bodies, a light produced by the simple excitation of the ether which is the source of all our light.

For household purposes the "incandescent" lamp is of course the best, as Mr. Edison foresaw in 1878. The "arc" lamp, with its intense glowing arch of carbon vapours, is a step beyond the candle or the gas flame in point of purity, and vastly superior in point of brilliancy; but there is combustion here too, and certain noxious fumes and red-hot sparks are given off during its action. Though suitable for lighting public spaces, streets, yards, and lighthouses, it is not adapted to the home. The incandescent lamp, in which the light is produced by a white-hot carbon filament traversed by the current in a vacuum tube or bulb of glass, is manifestly our household light, at least until we get a better.

Its merits lie in its healthiness, its safety as compared with gas, and its intrinsic beauty.

The healthiness of it is absolute. The hermetically sealed glass globe enclosing the white-hot wick or filament does not permit the light either to pollute or to consume the air. A gas or candle flame not only burns the air in a room which should be breathed, but pollutes the air which is left to be breathed with smoke, carbonic acid, and other gases. People are hardly alive to the deleterious influence of gas-jets on the health. We often hear, it is true, of headaches and lassitude, produced by crowded rooms and gas-burners; but the slow poisoning these produce is as a rule overlooked, because it is not easily traceable, and cannot very well be avoided so long as gas is used. With the incandescence lamp in our homes we shall be able to breathe a fresher, healthier atmosphere there, and visits to the theatre or lecture hall lit by the same means will not be undertaken at the risk of headache and nausea. The comparative coolness of the light as compared with gas must also be considered in its favour in respect of healthiness; for the oppressive heat of assembly rooms is generally due to gas-light. A number of people crowded together are sufficient to generate heat enough to keep themselves warm except in cold weather; and heat, if it be wanted, can be supplied by special means without depending for it on the means of lighting. The cleanliness of the incandescence light is also an advantage, though a minor one perhaps. It has no oil to spill or smoke to settle upon furniture, and the glass bulb can easily be kept clean.

The safety of the electric light as compared with gas requires little demonstration. It is not, of course, absolutely safe; for an accident to the wires might cause a spark to develop and set fire to something inflammable. But it is free from the terrible explosive power of coal-gas or petroleum; and it must be a very inflammable substance

* A paper read before the Athenæum Society.

which will ignite by the electric spark. The wires will be carefully insulated according to rules laid down beforehand; and it has been shown again and again that if the lamp itself be broken, the white-hot filament is dissipated by the inrush of air into the vacuum, and nothing is left to set fire even to the lightest gauze or muslin.

As for the danger to life and limb from electric shocks produced by the current, that can be avoided by employing currents of lower electromotive force than will prove fatal to the tissues of the body. There are one or two systems of lighting in which "high tension" currents, which might kill, are used, but there are many other systems on which the light is produced with perfectly harmless currents; and these are likely to prove the fittest in the end; for, give the public an equally good light which is free from peril to the body, and they will certainly choose it in preference to one which was a kind of lurking death.

The beauty of the incandescent light is another of its merits. The rich golden glow of the carbon filament resembles the light of a wax-taper: only it is not blown about by the air, and requires no snuffing. The steadiness is equal to the brightness of it. Being fumeless, it does not tarnish gilding, and thus it can be used in picture galleries and richly ornamented rooms where gas would be prohibited. Great expense in re-gilding public halls and dining rooms will thus be saved by its use. Moreover it can be used with impunity in libraries where gas would rot the morocco or russia bindings of the books in five or seven years.

It lends itself very readily to decorative purposes. Wherever a wire can be led it can be taken; and we may see it burning in the midst of flowers, ferneries, trees, or in the water of aquaria. The floral chandelier, on which the incandescence bulb is shaded by the cup of various flowers in coloured glass, is already a well-known form of ornamental lamp-holder, and workers in brass have opened up a new branch of business in designing electric light fittings. Workers in glass, too, have a new field here, in preparing coloured shades of different tints for ornament, or for such purposes as photography, and for scenic effects.

I do not propose to enter into the question of expense, or the methods and means of supplying the light, further than to say that the expense will be no obstacle when lighting operations are begun on a large scale, and that the most reliable method of lighting a house is by means of a generator combined with storage batteries to maintain the light in case of mishap to the generator. The latter may either be a dynamo-electric machine, or the hitherto neglected primary battery, which has the great advantage for isolated installations in requiring no motive-engine, with its drawbacks of noise, smoke, or fuel. The measurement of the current can be effected by such electric meters as have been devised by Edison, Boys, Hopkinson, and Professor Ayrton and Perry. Current-meters will be used to measure the quantity of current supplied; and energy-meters if the electricity is also to be used for motive-power, such as the driving of lathes, sewing machines, punkahs, and so on. This double service of the electric current is likely to prove of much convenience, and will probably give rise to quite a number of labour-saving devices for household use in future.

The electric incandescent lamp is so light and movable that it will be very handy in the home. If a person is an amateur mechanic, or photographer, or microscopist, he can adapt it readily to his lathe, his developing closet, or his microscope. Mr. Stearns has fitted the Swan lamp to the microscope with much ingenuity and success, and Mr. Stanley has also succeeded in photographing microscopic images very well with it by aid of a lens or two, and without using a camera.

In the library it will be especially useful for reading by, and as it can be switched from one lamp to another in a room wherever it is wanted, not more than a single lamp need be used at a time in many cases; for the light can be directed to the point where it is wanted. It cannot, of course, be carried about in the hand as easily as an oil lamp or candle, unless indeed flexible cord conductors are used, and it cannot yield a light for a cigar or cigarette; but these are trifling drawbacks which the humble match and candle will make good.

Some time ago an American physicist, Professor Pickering, investigated the cause of the bad eyesight so common amongst Harvard students, and traced it to the heat given off by their reading-lamps. Heat, not light, was the source of trouble, and it appeared to act by drying the moisture of the eyes. He therefore concluded that the electric light would be better for the eyes than gas or oil lamps. But it is a common remark among electric light engineers that their sight is going bad; and there is no doubt that looking at electric lights is very injurious to the eyesight, temporarily at least. Here the cause is obviously not heating, and the recent experiments of M. Chardonnet, communicated to the French Academy of Sciences, would seem to point to the ultra-violet or actinic rays as the cause of the evil. M. Chardonnet finds that the ultra-violet rays are absorbed by the crystalline lens of a healthy eye, and as the electric light from the "arc" lamps is excessively rich in these rays, he infers that the lens must be injured and too much taxed by the light of an arc lamp. The light from incandescence lamps, such as those of Swan, Edison, and others, is not rich in these rays, and is therefore in his opinion better adapted for homes. As it gives off little heat either, it is evidently the kind of reading-lamp for persons with weak eyes. But in spite of the heat and actinic rays, we are inclined to think that the very brilliance of the electric light is detrimental to the eyes, which suffer from excess of light. Therefore it is that on looking at the glowing filament of an incandescence lamp the eyes are dazzled for some time to come; and hence it is advisable to screen or shade the white-hot filaments from the line of sight.

The electric reading lamp exhibited here to-night has been devised by the author, and made by the Duplex Electric Light, Power, and Storage Company, of Soho Square. It consists of a mahogany base, enclosing a battery of seven cells, of the kind arranged by Mr. G. V. Holmes and Dr. S. H. Emmens, and consists of six-sided cells of carbon, each containing a zinc rod, in a porous pot, immersed in the exciting solution. From this base rises a light tubular standard of metal, carrying a jointed arm, to the end of which is attached the lamp by a socket. A movable screen to shade the filament and reflect the light is supported over the bulb by a smaller jointed arm. It will be seen that the lamp, which gives a good light of several candle-power, can be readily brought to any position with respect to the reader by reason of the joints in the arms and the turning-joint at the foot of the standard, which enables it to turn round its axis. The lamp also folds up into a slot cut in the upper part of the standard to admit the folded arm, and can in this way be transformed into an ordinary table-lamp.

ON WINDING ELECTRO-MAGNETS.

By Profs. W. E. AYRTON, F.R.S., and JOHN PERRY, M.E.*

THE following experiments were made to determine which mode of winding a given length of wire on an iron bar gave the strongest electro-magnet for the same current. Four bars of iron, each 12 inches long, were cut from the same rod $\frac{3}{8}$ inch thick; and an exactly equal length of wire was wound on the four bars respectively, in the following way:—

1. Wire wound equally over the whole length (fig. 1).
2. Wire coned towards each end (fig. 2).
3. Wire wound equally over half the iron bar, leaving the other end bare (fig. 3).
4. Wire wound on one half but coned towards the end (fig. 4).

Electro-magnet No. 1 was put so that its axis was at right angles to the axis of a small magnetic needle and passed through the point of suspension of the needle, which was suspended so as to move freely in a horizontal plane, and far enough away that the magnetic field due to the electro-magnet No. 1, when magnetised by passing a current through it, was nearly constant over that portion of the field in which the little suspended needle moved when deflected. A constant current was now passed through the coil on No. 1, and the deflection of the little needle observed when No. 1 was placed at different distances from the centre of the test-needle, the axis of No. 1, however, always remaining in the

* *Phil. Mag.*, *June*, 1883.

same line. Under these circumstances it is well known that the strength of the field produced by No. 1 at the centre of the test-needle is approximately proportional to the tangent of its deflection. Experiments were now made in a similar way with electro-magnet No. 2, and with each end of No. 3 and of No. 4, the same current as was employed with electro-magnet No. 1 being used in all cases, and which was much below the saturating current.

The results obtained are given in the accompanying table, and are shown plotted in the accompanying curves (fig. 5), vertical distances representing the distance between the near end of the electro-magnet and the centre of the test-needle, and horizontal distances the tangents of the deflection of the test-needle: AAAA is that for No. 1; BBBB for No. 2; CCCC for the covered end of No. 3; DDDD for the uncovered end of No. 3; EEEE for the covered end of No. 4; and FFFF for the uncovered end of No. 4.

Distance in inches between the near end of the bar and the centre of the test needle.	No. 1.		No. 2.		No. 3.				No. 4.			
					Covered end.		Bare end.		Covered end.		Bare end.	
	Def.	Tan.	Def.	Tan.	Def.	Tan.	Def.	Tan.	Def.	Tan.	Def.	Tan.
3½	79°	5·14	77°	4·33	82°	7·12	57°	1·54	67°	2·30	27°	0·57
4	77	4·33	71	2·9	77	4·33	53	1·33	62	1·88	21	0·38
5	69½	2·67	58	1·6	66	2·24	46	1·04	52	1·28	14	0·28
6	59	1·66	47	1·07	56	1·48	39	0·81	43	0·93	11	0·19
7	50	1·19	37	0·76	46	1·04	32	0·62	36	0·73	9	0·16
8	42	0·9	30	0·58	37½	0·79	27½	0·52	29	0·56	7	0·12
9	35	0·7	24	0·46	30	0·58	18	0·32	22	0·48	4	0·07
10	30	0·58	20	0·36	25	0·47	13	0·23	17	0·31	3	0·05

To ascertain the distribution of the lines of force, iron filings were sprinkled on paraffined paper, and the positions the filings took up fixed by the paraffine being softened by a heated piece of copper being passed over the paper at a short

FIG. 1.

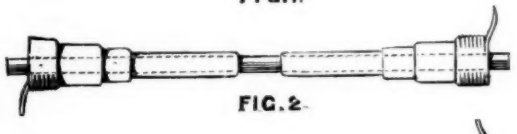


FIG. 2.

FIG. 3.

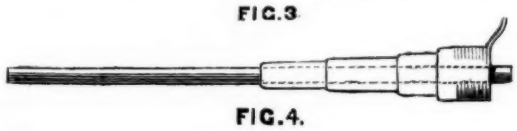


FIG. 4.

distance above it. From the curves in fig. 5 and from the iron-filing curves it was seen that the effect of coning the wire was to produce a strong field very near the pole, but that the force falls off very rapidly as the distance from the pole increases. With No. 2 magnet, for instance, the field between the poles is so weak that scarcely any definite arrangement of filings is traceable in the diagram corresponding with it.

From the curves in fig. 5 it is seen that, at considerable distances from the end of the electro-magnet, the uniformly coiled magnet No. 1 produces the most powerful field, while for points nearer the magnet, but still at a distance of about 3 inches from it, the covered end of No. 3 magnet, corresponding with the curve CCC, produces the strongest field, the next strongest being produced by the magnet No. 2 with the wire coned towards each end, since obviously the curve BBB cuts the curve AAA at a point corresponding with a distance of about 3 inches from the end of the magnet. For distances very close to the magnet this method of experimenting cannot, of course, be employed to measure the resultant force accurately; and hence observations by this method at distances of less than 3½ inches from the end of the magnet to the centre of the oscillating needle were not made, and conclusions as to the resultant magnetic force very close to the poles must, of course, not be drawn from the curves in fig. 4.

Returning to the curves taken up by the iron filings, No. 1 magnet gives an arrangement similar to that of an ordinary regularly magnetised bar-magnet. With No. 2 the lines around the poles are similar to those of No. 1, but the field between the poles is very weak. Magnets Nos. 3 and 4 give very similar figures, showing a very peculiar distribution of force. There is a great concentration of the lines at the pole corresponding to the half of the iron which is covered with wire; but the unwound end seems to form a long weak pole, with its maximum force near the centre of the bar, *i.e.*, at the inner end of the coil,—the differences between these two being, that with No. 4 magnet there is, comparatively, a greater concentration of force at the wound pole, and that the opposite pole is longer and extends a little way into the coil—the result of the coning of the wire. In these two cases the unwound end of the iron seems to act like an armature.

To ascertain the force which each magnet would exert on an armature, experiments were made and the following results obtained, the current flowing through the coil in each case being exactly the same, as well as the armature employed:—

Magnet.	Weight required to detach the armature from the covered end of the magnet.
No. 1	45 ounces
2	57 ,,
3	57 ,,
4	77 ,,

These results confirm those previously obtained, that the field produced by the covered ends of the electro-magnets numbers 2 or 3 at distances near the pole is much stronger than that produced by No. 1. But they show something else, viz., that for very small distances it is the covered end of No. 4 that produces the strongest field. In other words, returning to fig. 5, the curve, EE, although much below the curves, AA, BB, and CC, must rise rapidly and cut the others

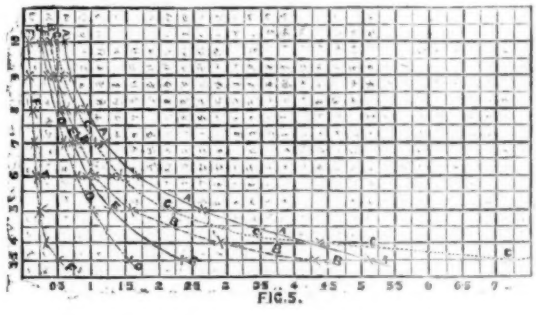


FIG. 5.

just as the curve, CC, cuts the curve, AA, at a point corresponding with a distance of about 4·2 inches from the end of the magnet, and just as, again, the curve, BB, cuts AA, at a point corresponding with a distance of about 3·2 inches from the end of the magnet. The curves of iron filings indeed give indication of the great strength and concentration of field there is produced close to the iron by the wire coned at the end, as employed in the magnet No. 4.

With, then, a definite iron core, a definite length of wire to be coiled on it, and to be traversed with a definite current, the mode of coiling to produce the largest field depends entirely on the distance from the end of the electro-magnet at which the field is to be produced. With the particular magnet we have employed we see that, at distances from the end of the magnet very small compared with the length of the core, the wire should all be coiled up at the near end of the core, as in fig. 4; to create a field at a distance from the end of the magnet equal to about a third of the length of the magnet, it is better to coil the wire uniformly over one half of the core, as in fig. 2, than to cone it up at the near end as in 4; while for distances from the end of the magnet equal to, or greater than, about ⅔ of the length of the core, the uniform mode of winding is the best.

We have to thank two of our students, Messrs. Sayers and Pink, for most cordial assistance rendered us in this investigation.

RESISTANCE OF WATER.

EXPERIMENTS TO ASCERTAIN THE ALTERATION OF THE RESISTANCE OF WATER UNDER DIFFERENT CURRENT STRENGTHS.

THESE experiments were carried out to solve the question of the effect of leakage in wet weather from aerial lines under currents of different strengths. Two copper wires ·069 inch in diameter formed the electrodes. They were immersed for 1½ inches in water in a glass vessel, whose dimensions were 2 inches depth, 1¾ inches width, and 1½ inches breadth. The wires were ¾ inch apart in the water. The results from Minotto Cells, one up to forty-six, through a tangent galvanometer, are given in the Table below:—

(1) *With reversed Currents.*

No. of cells.	Deflection through G. & R.	Deflection through water.	Resistance of G.	Comparison Resistance.	Battery Resistance.	Resistance of water.	Current (ampères) in circuit.	Remarks.
	Degs.	Degs.						
1	6	3	101·3	1959·7	16·6	4079	·00024	
2	11	14½	,,	,,	33·5	1436	·00126	
3	15¾	26	,,	,,	51·0	1073	·0024	
4	20¾	37	,,	,,	70·7	873	·0038	
5	24¾	45	,,	,,	83·6	780	·0052	
6	28	50½	,,	,,	103·8	747	.0063	
7	32	56	,,	,,	123·6	693	·0076	

(2) *Positive Current only : same water.*

7	30½	54	101·3	1959·7	123·6	714	·0074	
6	27	50	,,	,,	103·8	726	·0064	
5	24	44	,,	,,	83·6	802	·00506	
4	20	36	,,	,,	70·7	894	·0038	
3	15	26	,,	,,	51·0	1009	·0026	
2	10	13	,,	,,	33·5	1457	·00126	
1	5	3	,,	,,	16·6	3393	·00028	

(3) *Positive Current only : fresh water, and clean electrodes.*

1	6	6	101·3	1959·7	16·9	1960	·00048	
2	11½	16	,,	,,	33·8	1346	·00136	
3	16	27	,,	,,	50·7	1031	·0026	
4	21	36	,,	,,	67·6	959	·0035	
5	25	43	,,	,,	84·5	887	·0047	
6	29	49	,,	,,	101·4	835	·0058	
7	32½	53	,,	,,	118·3	826	·0067	Negative electrode coated with hydrogen.
8	36	57	,,	,,	135·2	795	·0077	
9	39	60	,,	,,	152·1	787	·0086	Bubbles of hydrogen streaming off negative electrode.
10	42	63	,,	,,	169·0	751	·0098	,, ,,
11	45	65	,,	,,	185·9	760	·0105	,, ,,
12	47	67	,,	,,	202·8	726	·0116	,, ,,
13	49	69	,,	,,	219·7	683	·0129	,, ,,
14	51	70	,,	,,	236·6	695	·0135	,, ,,
15	52½	71	,,	,,	253·5	684	·0146	,, ,,
16	54½	72	,,	,,	270·4	689	·0151	,, ,,
17	56	73½	,,	,,	287·3	645	·0166	,, ,,
18	57	74	,,	,,	304·2	635	·0173	,, ,,
19	58½	75	,,	,,	321·1	619	·0182	,, ,,
20	59½	75½	,,	,,	338·0	614	·0190	,, ,,
21	33	20½	1·0	200·1	371·8	124	·026	,, ,,
22	33½	21	,,	,,	..	..	..	,, ,,
23	34	21½	,,	,,	..	..	..	,, ,,
24	34½	22	,,	,,	..	..	..	,, ,,
25	34½	22½	,,	,,	..	..	..	,, ,,
26	35	23	,,	,,	439·4	606	·025	,, ,,
27	35½	23½	,,	,,	..	..	..	,, ,,
28	35½	24	,,	,,	..	..	..	,, ,,
29	35½	24½	,,	,,	..	..	..	,, ,,
30	35¾	24¾	,,	,,	..	..	..	,, ,,
31	36	25¼	,,	,,	..	..	..	,, ,,
32	36½	25½	,,	,,	..	..	..	,, ,,
33	36¾	26	,,	,,	..	..	..	,, ,,
34	37	26¼	,,	,,	574·6	611	·029	,, ,,
35	37	26½	,,	,,	..	..	..	,, ,,
36	37½	27	,,	,,	614	599	·029	,, ,,
37	37¼	27	,,	,,	..	..	..	,, ,,
38	37¼	27½	,,	,,	..	..	..	,, ,,
39	37½	27½	,,	,,	..	..	..	,, ,,
40	37¾	27¾	,,	,,	..	..	..	,, ,,
41	37½	28	,,	,,	..	..	..	,, ,,
42	37½	28	,,	,,	732·1	611	·031	,, ,,
43	37¼	28¼	,,	,,	..	..	..	,, ,,
44	37¾	28¼	,,	,,	..	..	..	,, ,,
45	38	29	,,	,,	791·3	597	·032	,, ,,
46	38	29	,,	,,	811	615	·032	,, ,,
58	37½	30	,,	,,	1047·9	612	·0349	,, ,,

(4) *With Cells Coupled to reduce Internal Resistance of Battery.*

No. of cells.	Deflection through G. & R.	Deflection through water.	Resistance of G.	Comparison Resistance.	Battery Resistance.	Resistance of water	Current (ampères) in circuit.	Remarks.
5	27½	51¼	104·3	1998·4	84·5	717	·0055	5 single cells in series
5/2	27½	51¼	,,	,,	42·2	741	·0056	5 double ,,
5/3	28	51	,,	,,	28·2	784	·0054	5 treble ,,
10	44½	66	,,	,,	169	726	·010	10 single ,,
10/2	45½	68½	,,	,,	84·5	666	·0117	10 double ,,
10/3	46	69	,,	,,	56·3	703	·0115	10 treble ,,
15	54½	72	,,	,,	253·5	702	·014	15 single ,,
15/2	56	74½	,,	,,	126·7	683	·016	15 double ,,
15/3	56½	76	,,	,,	84·5	642	·018	15 treble ,,
20	34	21	0·75	199·4	338	608	·021	20 single ,,
20/2	43½	25¼	,,	,,	169	569	·027	20 double ,,
20/3	47½	27	,,	,,	112·6	556	·030	20 treble ,,

(5) *Influence of Time, with constant E.M.F. continuously applied.*

10	43	63	104·3	1998·4	183	798	·0091	9.15 a.m.
,,	,,	63	,,	,,	,,	798	·0091	9.40 a.m.
,,	,,	61	,,	,,	,,	893	·0085	10.25 a.m.
,,	,,	61	,,	,,	,,	893	·0085	11 a.m.
,,	,,	60	,,	,,	,,	942	·0080	11.7 a.m.
,,	,,	58	,,	,,	,,	1043	·0075	12.15 p.m.
,,	43	56½	,,	,,	,,	1122	·0071	1.10 p.m.
,,	,,	55½	,,	,,	,,	1176	·0069	1.45 p.m. [up
,,	,,	57	,,	,,	,,	1096	·0072	2 p.m. Water shaken
,,	,,	60	,,	,,	,,	942	·0080	2 p.m. Fresh water
,,	,,	63	,,	,,	,,	798	·0091	2 p.m. Clean electrodes.

It will be seen that the resistance decreases to a certain point, about 600 ohms with 20 cells, then remains fairly constant with an increased electromotive force. What change occurs in the water to reduce the resistance it is difficult to say. Not chemical changes, for if fresh water be taken the same resistance, or practically the same resistance, is at once obtained for the same E.M.F.; not evolution of gases at the electrodes, for the water may be shaken up and the same resistance is still maintained; and not to deposits on the electrodes, since the wires may be cleaned and the same results obtained. The fact remains that water, or a fault on a line caused by rain or mist, will alter its resistance according to strength of current, and it has a most interesting practical bearing upon experiments in transmission of power to a distance, and upon the best strength of signalling currents for wet weather; in the latter case it is evident that the feeblest current which will safely work the instrument should be employed, and that a large increase of electromotive force at the sending station is not an advantage.

The powerful currents of a dynamo machine may influence a water resistance to a much larger extent, but probably not in a different manner.

Iron wires under similar circumstances give a smaller resistance than copper; but the progressive decrease in resistance with increased E.M.F. is much the same. Table 4 shows how, with a small E.M.F. and increased quantity, the resistance actually rises, and how as the E.M.F. is increased this effect of decomposition is overcome and the resistance again falls.

Table 5 shows how with a moderate E.M.F. the decompositions by a continuous application of the current causes the resistance to rise, and on examining the vessel the hydrogen may be seen bubbling off the negative electrode, while a cloudy blue precipitate surrounds the positive electrode. To positive signalling currents must be attributed the well-known fact that a telegraph line assumes for a positive current a higher resistance than for a negative current; the constant application of these currents must cause oxidisation of the points of support of the line. There is no great difference, or rather scarcely any perceptible difference in the readings of positive and negative currents passed through a watery film on the surface of an insulator.

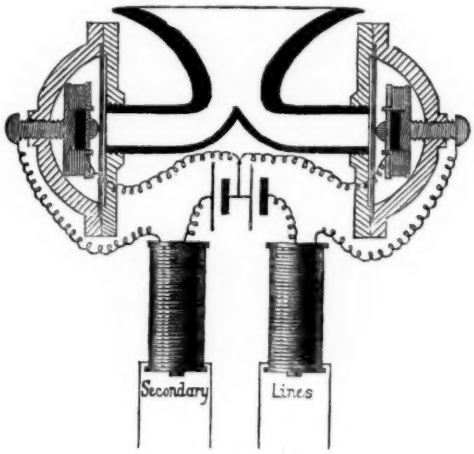
Whether the results in table 4 will hold good for powerful currents in wet weather, in transfer of force to a distance, or whether such currents will follow the results of table 5 must be found by practical trial.

E. O. WALKER.

Belgaum, 1*st May*, 1883.

THE EDISON DUPLEX TRANSMITTER.

WE recently gave an illustration and a short description of the Baxter telephone transmitter, one of the numerous instruments which had been experimented with in the long-distance telephony tests between New York and Chicago. It has been suggested to us that we should adopt a similar course with regard to the Edison transmitter as used by the



Bell Telephone Company for the same tests. As in the former case we reproduce our sketch from *The Electrical World* of New York. It will be seen that the instrument is a combination of two ordinary Edison carbon transmitters arranged so that the impulses of the voice may affect both equally. Each half has its own induction coil and is separately connected in its own battery and primary wire circuit, and the secondary circuits may of course be joined up as desired.

INDIVIDUAL TELEPHONE SIGNALS.

IN the columns of our journal for July 15th and July 29th, 1882, we illustrated and described the telephone call signals of Mr. Kettell and Messrs. Harrison, Cox-Walker & Co. respectively. We notice in the New York *Electrical Review* a similar instrument devised by Mr. Cary, and this we reproduce in the interests of our telephonic readers.

Fig. 1 represents the form of instrument adopted for use

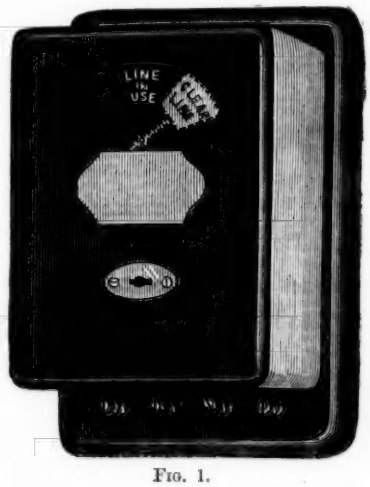


FIG. 1.

in subscribers' stations, and fig. 2 shows the same as it appears with the external case removed to show the mechanism or to adjust the same.

Externally, as shown in fig. 1, all that is seen is a neat case, with an aperature at its upper part showing, when the line is free, a shield bearing the words "Clear line;" while when any subscriber is conversing the shield moves to one side and exhibits the words, "Line in use." Four binding screws for attaching the wires are fixed to the baseboard, two being for the main line wires, and the remaining two for the wires leading to the magneto-bell or local circuit, depending upon the character of system adopted.

The working parts, shown in fig. 2, consist of an electro-magnet in the main line circuit, provided with a neutral or soft iron armature, carrying and actuating a light rod or lever, furnished at its upper end with a pawl jointed to it, and adapted to operate a ratchet wheel, and thus to rotate the shaft or arbor upon which the ratchet wheel is fixed. Of course, the ratchet wheel moves by means of the pawl the extent of one tooth, with each electrical pulsation.

The armature lever in addition to the above, moves also simultaneously with its pawl, and by means of an ingenious cam device, a detent lever, which engages a second ratchet wheel on the shaft, but toothed in a direction opposite to the first, and by such engagement prevents what has sometimes occurred in other step-by-step signals, *i.e.*, the advance of the ratchet wheel of more than one tooth, with a single pulsation.

This is a most important feature and adds much to the certainty of the operation.

Upon the same shaft that carries the two ratchet wheels is also fixed a rotating metallic disc, having at one point on its edge a non-conducting space, produced either by an actual depression, or by a piece of some good conductor let into the edge. This is fastened on by a set screw, and

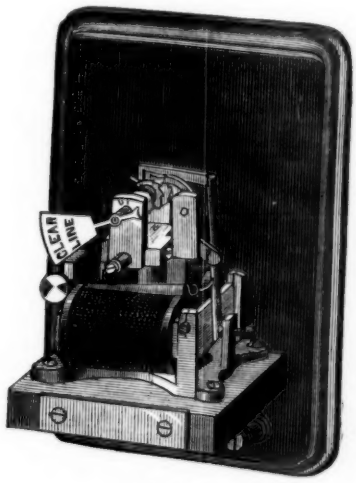


FIG. 2.

operates as a circuit changer, or shunt circuit breaker. A contact spring is adjusted to bear firmly upon the edge of the disc at all times, except when its bearing part, in the rotation of the disc, comes opposite the non-conducting part or depression in the edge. A second contact spring rests constantly in contact with the shaft, and the two springs together with the metal disc, act as a cut-out or short circuit round the ringer, which may be and usually is, the ordinary magneto-bell; and at all times all the bells on the circuit are cut out, except the one which is being called; and that one is introduced into the main circuit, when at that station the short circuit round it is broken, by means of the passage of the depression of the metal disc under the first contact spring; so that the contact between the disc of the spring is for the time broken.

By means of the set screw, the circuit breaker may be adjusted upon the shaft, so as to break the short circuit, and thus effect the signal at any desired point in its revolution. The system is operated by sending to line successive impulses of constant direction or polarity, say, positive, which may be developed either from a battery or a magneto-generator, although the latter is usually preferred because it requires less care, is cleaner, is more powerful, and takes up less room. If, however, such a generator is used, it must be provided with a commutator, so as to send straight currents when required. As soon as a suitable number of constant currents have been sent to line, to bring the desired bell into circuit, the bell is rung by sending a regular magneto alternating current; and the same machine which

is fitted with the commutator to furnish the constant currents, may readily be adopted by a special arrangement of wires to furnish also the alternating currents.

Not only, however, is this apparatus adopted to ring the magneto-bell. By a slight modification in the metallic circuit changing disc, it is fitted to close the circuit of a local battery, and thus ring a vibrating bell.

As already indicated, it is most essential that a common zero point, or unison, be provided in instruments that have a progressive or step-by-step character of advance, in order that if any of the distant instruments be thrown out of correspondence with the rest (whether by lightning discharge, or by a cross with a battery wire, or by the experimental researches of the subscriber), it may be brought back into correspondence by a simple operation performed at the central station. This is done in the Cary instrument by a simple device. At a suitable place upon the revolving shaft a projecting pin is fixed.

In all the instruments the pin is fixed at the same point. A pivoted magnetised bar of steel, technically called a polarised armature, hangs between the electro-magnet cores and responds to changes in direction of current, although not to make-and-break signals. When the currents transmitted are of the direction which is used to advance the signals, they also act upon the polarised armature and tend to swing its free end into the path of the pin on the revolving shaft, so that as soon as the shafts of all the signals reach that point they are stopped and can go no further, no matter if the pulsations are continued ; so that if from any reason one or more of the bells get behind the others, they are all brought together again when the pin of each reaches the polarised lever ; and this occurs each time

FIG. 3.

the line is used. It is when the instruments are thus at unison that the "line in use signal" appears at the aperture, and the method of operation adopted in signalling is, first to send the requisite number of pulsations to call any individual instrument of the series ; and after thus attracting the attention of the subscriber, to inform him what is wanted, and then before he commences his conversation, to run the instruments round to complete their revolution, so as to show the "line in use" signal. This signal is marked on a dial, and a second visual signal, *i.e.*, "line clear" is fixed at one end of a pointer which rotates with the shaft. This is brought into view, and remains opposite the aperture at all times when the line is not occupied.

The apparatus is released from unison by a single electrical pulsation of the direction opposite to that used to advance the signals ; this acting to swing the polarised lever out of the way of the pin. The entire apparatus has worked well with the magneto-bells of all the authorised manufacturers, not only on the wall of an experimenting room, as is too frequently the case, but also on actual working lines.

Ordinarily they are arranged to allow six stations on a line, as experience shows that not more than that number of telephones can usually work harmoniously together, but in those rare cases where more than six are wanted, as in long lines which are rarely used, the number can readily be doubled, without change in the dials or mechanism ; and if at any time it should be deemed advisable to crowd the line to such an extent, even fourteen stations can be provided for. There is nothing slow about this signal, since in trials made it has been found a very easy thing to call the last station on the line in three seconds. There is no clockwork to wind up ; nor is there any delicate mechanism too fragile to be looked at in the device, but every part is solid and strong.

Some of the most important features are protected by the patents, granted and pending, of Mr. James H. Carey, who has also recently produced an automatic calling apparatus, which rings the desired bell without giving the central office operator the trouble and responsibility of counting.

At the central station, for the information of the operator, a duplicate instrument is usually placed, which, as shown on fig. 3, has an index pointer and dial, by which the movements of the mechanism are visually indicated to the operator.

These signals are undoubtedly eminently adapted for work on long lines, or through lines of high resistance, on account of their adaptation for the employment of the magneto-currents in all their functions.

A large number of the instruments are now being manufactured for the Cary Company by the Western Electric Company, arrangements for that purpose having been made with the American Bell Telephone Company.

THE FIRST TELEPHONE.

By Professor SILVANUS P. THOMPSON.*

ON the 12th of May, 1862, there was met together in a fine old hall in the city of Frankfort-on-the-Main a crowded audience, eager to see and hear the latest scientific invention expounded by its inventor. The occasion was the meeting of the Free German Institute (Freies Deutsches Hochstift), a sort of literary and philosophical society, which has since domiciled itself in the historical old house where Goethe was born. The invention which attracted so notable a crowd was the telephone. The inventor was Philip Reis, a teacher of natural sciences in Garnier's Institute, a flourishing boys' school at Friedrichsdorf, near Homburg.

On one occasion previously had the telephone been publicly exhibited ; namely, at a meeting of the Physical Society of Frankfort, on the 22nd of October in the preceding year.

In the journal of the Frankfort Society (*Jahresbericht des Physikalischen Vereins zu Frankfurt am Main*) for 1860-61, p. 57, may be found the memoir of Philip Reis on the subject, under the title "On Telephony by the Galvanic Current." In this memoir, which shows a marvellous precision and a grasp of the subject that excites admiration and wonder, the author says : "I have now succeeded in constructing an apparatus by means of which I am in a position to reproduce the tones of divers instruments, and even to a certain degree the human voice." The inventor further says—"Since the length of the conducting wire may be extended for this purpose just as far as in direct telegraphy, I give to my instrument the name 'Telephone.'" Toward the end of the memoir it is stated that until now it had not been possible to reproduce the tones of human speech with a distinctness sufficient to satisfy everybody ; adding : "the consonants are for the most part tolerably distinctly reproduced, but the vowels not yet to an equal degree." The author of the memoir in which these statements occur had been led to his invention by a remarkably suggestive line of thought. He had wanted an instrument to transmit electrically everything and anything that a human ear could hear. Accordingly he took the human ear itself as a model. "How," he argues, "could a single instrument reproduce at once the total actions of all the organs operated in human speech ? This was ever the cardinal question. At last I came by accident to put this question another way : How does *our ear* perceive the total (or resultant) vibrations of all the simultaneously-operant organs of speech !" He then goes on to describe the action

* Reprinted from the Proceedings of the Bristol Naturalists' Society.

of the auditory ossicles when the ear is made the recipient of sound; pointing out how they execute movements and exert forces upon one another in proportion to the condensations occurring in the sound-conducting medium and to the amplitudes of vibration of the tympanum. Having stated this law of proportion between the cause and its effect he goes on to speak of the graphic method of representing varying forces, such as those of sound-waves, by curves; and emphatically lays down that the ear is absolutely incapable of perceiving anything more than can be

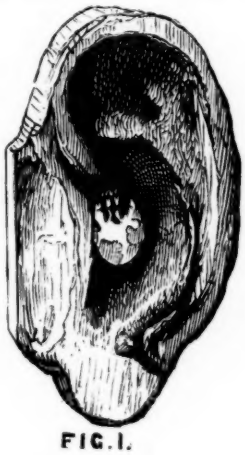


FIG. 1.

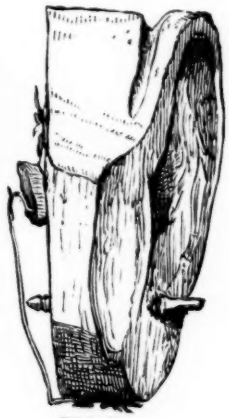


FIG. 2.

expressed by such a curve. After giving samples of undulatory curves corresponding to musical and to discordant sounds, he makes the following significant remark:—"So soon, therefore, as it is possible at any place and in any manner, to set up vibrations whose curves are like those of any given tone or combination of tones, we shall then receive the same impression which the tone or combination of tones would have produced upon us. Taking my stand upon the preceding principles, I have succeeded in constructing an apparatus," &c. He concludes his paper by saying that the newly-invented phonautograph of Duhamel may perhaps afford evidence as to the correctness of the views which he has asserted respecting the correspondence between sounds and their curves.

The actual apparatus figured in this memoir, and exhibited to the Frankfort Society in October, 1861, is now in my

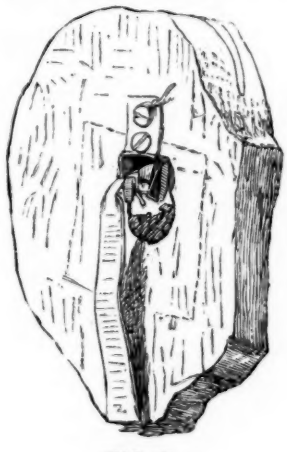


FIG. 3.

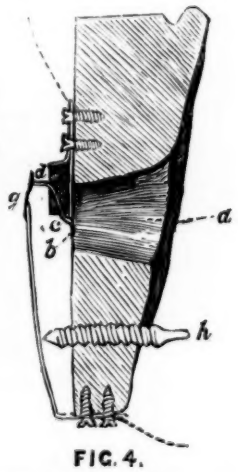


FIG. 4.

possession; and I have also temporarily intrusted to me a still earlier experimental telephone, made by Philip Reis, in the form of a model of the human ear.* This interesting instrument is depicted in its actual condition and size in figs. 1, 2, and 3, and in section in fig. 4.

It is carved in oak-wood. Of the tympanic membrane only small fragments now exist. Against the centre of the tympanum rested the lower end of a little curved lever of platinum wire, which represented the "hammer" bone of the human ear. This curved lever was attached to the membrane by a minute drop of sealing-wax, so that it moved in correspondence with every movement of the tympanum. It was pivoted near its centre by being soldered to a short cross-wire serving as an axis. The upper end of the curved lever rested in loose-contact against the upper end of a vertical spring, about one inch long, bearing at its summit a slender and resilient strip of platinum foil (see fig. 4). An adjusting screw served to regulate the degree of contact

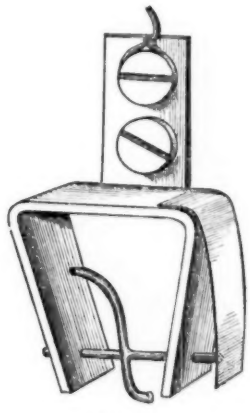


FIG. 5.

between the vertical spring and the curved lever. Conducting wires by means of which the current of electricity entered and left the apparatus were affixed to screws in connection respectively with the support of the pivoted lever and with the vertical spring. A springy strip of platinum pressed against the end of the pivot of the lever (as shown enlarged in fig. 5) to insure good electrical contact.

If now any words, or sounds of any kind, were uttered in front of the "ear," the membrane was thereby set into vibrations as in the human ear. The little curved lever took up these motions precisely as does the "hammer"-bone of the human ear; and, like the "hammer"-bone, transferred them to that with which it was in contact. The result was that the contact between the upper end of the lever and thespring was caused to vary. With every rarefaction of the air the membrane moved forward, and the upper end of the little lever moved backward, and pressed more firmly than before against the spring, making better contact, and allowing a stronger current to flow. At every condensation of the air the membrane moved backwards and the upper end of the lever moved forward, so as to press less strongly

FIG. 6.

than before against the spring, thereby making a less complete contact than before; and, by thus partially interrupting the passage of the current, caused the current to flow less freely. The sound-waves which entered the air would in this fashion throw the electric current, which flowed through the point of variable contact, into undulations in strength. Reis himself termed the contact-part of his telephone an "interruptor." That it was not intended to operate as an abrupt make-and-break arrangement, as some persons have erroneously fancied, is evident; firstly, because the inventor introduced delicate springs to give a following-contact (like that in Blake's well-known "transmitter"), and so prevent abrupt breaks from occurring; secondly, because abrupt breaks would have violated the fundamental principle to

* The property of Léon Garnier, Esq., Director of Garnier's Institute at Friedrichsdorf, near Homburg, where Philip Reis was formerly teacher of Natural Sciences.

which he refers in the sentence immediately preceding his description of the instrument shown to the Frankfort Society, namely, that of creating tones whose curves were like the undulatory curves imparted at the transmitting end of the instrument; thirdly, because (in another article) he described his instruments as opening and closing the circuit in proportion to the sound-wave; which obviously an abrupt "break-and-make" apparatus without a spring-contact could not possibly do. The mechanism which Reis thus invented—and which is substantially alike in all his instruments—might be appropriately described as the combination of a tympanum with an electric current-regulator; the essential principle of the electric current-regulator being the employment of a loose or imperfect contact between the two parts of the conducting system; those parts being so arranged that the vibrations of the tympanum would alter the degree of contact, or occasion an approach and recession of the atoms of the two surfaces, and so vary the resistance offered at the point of contact to the flow of the current.

The particular form of the instrument shown at Frankfort in 1861, and described in the Journal, is somewhat different from the "ear." The description is taken from the Journal.

"In a cube of wood there is a conical hole, closed at one side by the membrane (made of the lesser intestine of the pig), upon the middle of which a little strip of platinum is cemented as a conductor of the current. This is united with the binding-screw, *p*. From the binding-screw, *n*, there passes likewise a thin strip of metal over the middle of the membrane, and terminates here in a little platinum wire which stands at right angles to the length and breadth of the strip. From the binding-screw, *p*, a conducting wire leads through the battery to a distant station." In the original instrument there is also an adjusting-screw to regulate the contact, though this was not shown in the drawing in the Frankfort Journal.

The receiver used to reproduce the sounds transmitted by

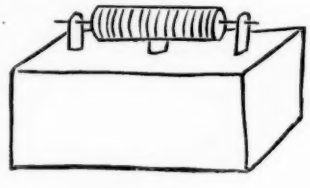


FIG. 7.

these telephones is also described in the memoir of Reis. It consisted of a steel needle surrounded by a coil of wire. This was at first set up—for the purpose of increasing the sounds by resonance—upon the top of a violin, as shown in fig. 6; later it was mounted upon a pine-wood box, as in fig. 7; to which still later a lid of thin pine was added, against which the listener could press his ear. The sounds emitted by such a wire during magnetisation and demagnetisation were well-known before, but to Reis is due the discovery that other tones than the natural vibration-tone of the wire could be electrically imposed upon it by the varying magnetising power of the current traversing the surrounding coil. Reis explained the reproduction of the transmitted sounds by supposing a magnetic attraction between the atoms of the steel wire to work synchronously with the fluctuations of the current. He later devised a different receiver, in which an electro-magnet was provided with an elastically mounted armature of iron attached to a light and broad lever, which it threw into vibrations corresponding to those of the original sound-waves. With this apparatus, and a transmitter with a small curved lever, in shape like that in the "ear," he was able (see Kuhn's "Handbuch der Angewandten Elektricitätslehre," 1866, p. 1,021), not only to reproduce melodies with astonishing exactness, and single words as in speaking and reading less distinctly, but even to transmit the inflexions of the voice expressive of surprise, command, interrogation, &c.

Considering how far these early researches were carried, it is remarkable that their historic value has been so greatly overlooked. The transmitters which Reis devised embody—though their mechanical design is less perfect and their performance consequently less certain—all the essential principles of the telephonic transmitters in use to-day, such as Blake's, Berliner's, and Crossley's. The receivers devised by Reis, more particularly the second form, anticipate every principle essential in the more modern and convenient receiver of Graham Bell, having an electro-magnet combined with an armature capable of inductive action—*i.e.*, made of iron, elastically mounted, and having an extended surface. Bell made the very great improvement of uniting these three qualities, essential to the armature, in one, by employing as armature a thin flexible iron plate. It is but just to the later inventors to add that both Bell and Edison have explicitly referred to Reis's prior work, Bell even going so far as to name the pages of Kuhn's Handbook from which the preceding reference is taken.

AN EXPLANATION OF THE GRAMME RING.

By H. CUNYNGHAME. *

IT is assumed by the theory which represents magnets as acting by means of lines of force—1. That lines of force proceed from the north pole of every magnet towards the south poles of the same or of different magnets. 2. That these lines of force are mutually repellent, and thus jostle or thrust one another out of the straight path, so that many are forced to take a circuitous route. 3. That the lines of force repelled from a north pole are attracted by any south pole, which they enter, and traverse the magnet and then come out again at the north pole, and so go round and round. 4. That the direction of these lines of force at any point indicates the resultant direction of the magnetic force at that point, and the number of the lines of force at any point indicates the strength of the field at that point. 5. That when a closed metallic circuit is moved from any position in which a number of lines of force thread through it to one in which the number of lines threading through it is increased or diminished, then a current flows along the circuit while the motion lasts. 6. The direction of this current so generated may be remembered by imagining a watch placed with its face turned towards the lines of force to the north pole from which they proceed. If the watch is pushed forward or moved so that the *number* of lines of force passing through its face is increased, a current will proceed through a coil wound round its rim in the reverse direction to the motion of the hands, if it is pulled back or moved so that the number of lines of force passing through its face is diminished, then a current will proceed through the coil in the same direction as the hands. 7. Or, again, the total effect of a ring in cutting lines of force is only the effect compounded of the effect of each portion of the ring; and, as each elementary portion of the ring cuts any lines of force, currents will be developed in such portion. The direction of the currents so generated may be remembered as follows. Suppose that the lines of force are showered out like streams of water from a garden-hose. They may be twisted about in all directions, or even curved and blown back by the wind. Now let a man made of copper walk along and the stream play on him. Then, if it strikes his back or his front directly, no current will be produced, but if it strikes anywhere on his left-hand side, a current will be sent from his head to his feet; if on the right-hand side, a current will be sent from his feet to his head. Thus in fig. 1 the man, A, has a current produced which goes from his head to his feet, while that produced in B is from his feet to his head. It does not matter from what side of the man the lines of force *proceed*, the question is the direction *in which they strike him*.

8. Iron, steel, nickel, and other bodies have a high magnetic inductive capacity. That is, lines of force prefer, when possible, to pass through them. They are hence said to be paramagnetic, and if placed in a magnetic field will draw to themselves lines of force. This is shown in fig 2, which has been prepared by sprinkling iron filings on a piece of glass covered with gelatine, under which two magnets have been placed, with a small block of soft iron between them. It is to be noticed how the lines curve in towards the block of iron in the centre.

Let us apply these theories.

Suppose that a ring, mounted at the end of a radial arm, were moved round between two magnets, N and S, fig. 3.

* Extracted, with some modifications, from Mr. Cunynghame's forthcoming book, "The Law of Electric Lighting."

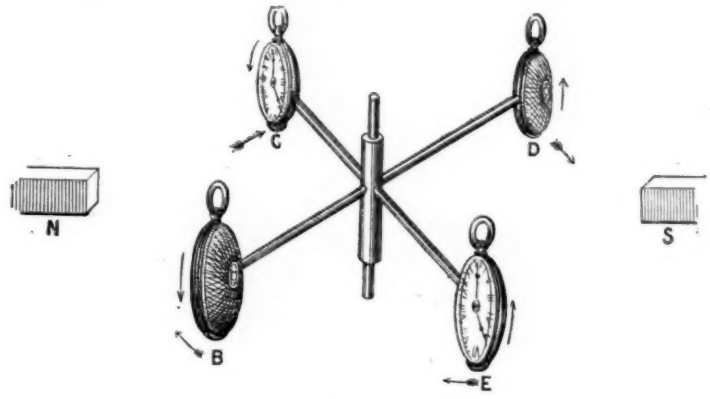


FIG. 3.

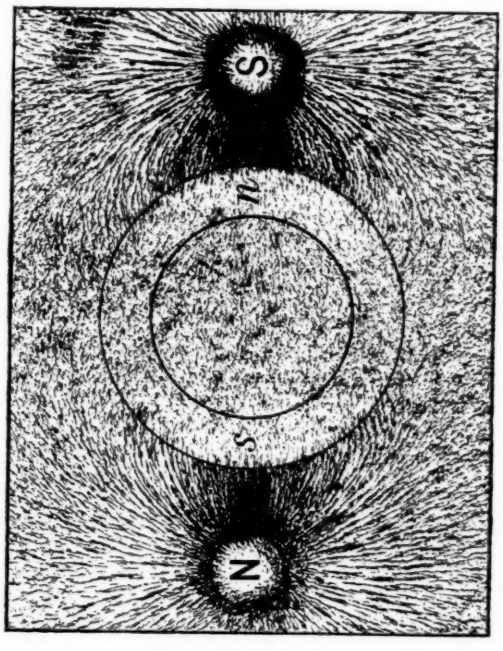


FIG. 5.

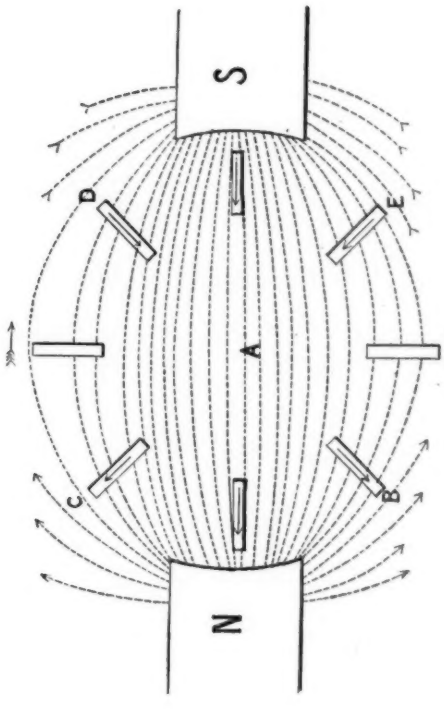


FIG. 4.

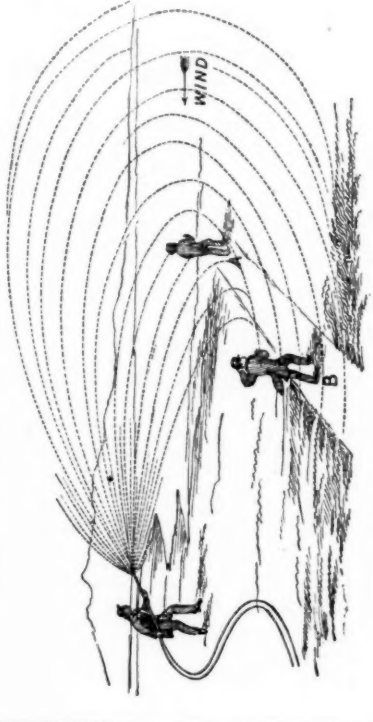


FIG. 1.

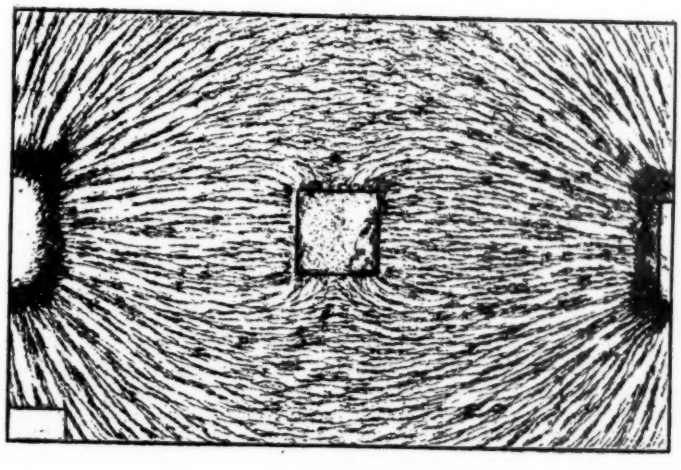


FIG. 2.

Then, in accordance with our theory, while the ring moved from B to N, a current would be generated in the same direction as the hand of a watch, as shown in the figure by the small arrow. From N to C the current still continues in the same direction. Between C and D but little effect is produced, for the receding motion of the ring is about counterbalanced by its twisting motion, and the number of lines of force passing through it remains about the same. But midway between C and D the current is reversed and continues reversed till the ring is midway between D and B, when the original direction is restored. This is typical of the action of a ring without iron moving in a field of force. The arrangement is also shown in plan at fig. 4. Now, suppose that if a mass of iron were placed in the centre of the rotating ring, and as the ring rotates in a circle, we may place inside it a complete ring of iron.

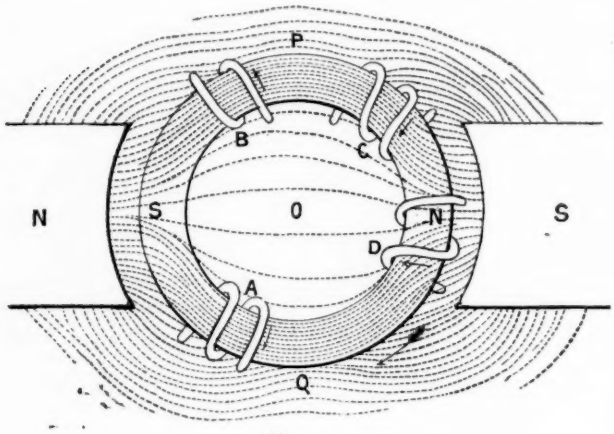
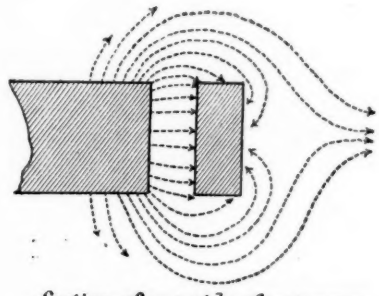


FIG. 6.



Section of one side of a gramme ring

FIG. 7.

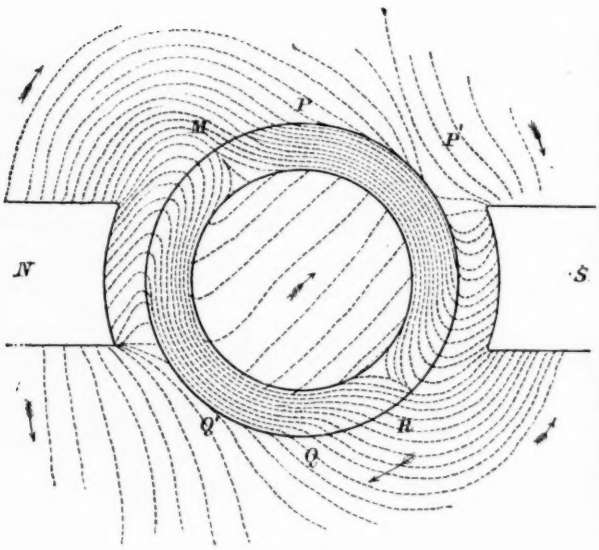


FIG. 8.

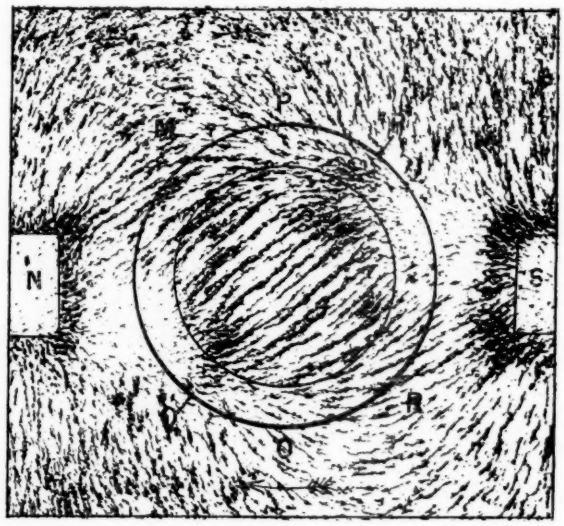


FIG. 9.

The effect of this ring of iron will be to attract and draw in the lines of magnetic force.

It is a very useful experiment to take a ring of iron, say six inches in diameter, and place it in a magnetic field, and then explore the lines of force which pass through it. As a rule, they divide at the nearest point to the magnet or magnets, and then flow round the ring. Only a few traverse it. The nature and direction of these lines may be investigated by means of a very small mariner's compass, such as one buys for 6d. It shows the direction of the lines of force, and if the glass be taken out so as to expose the needle, and a gentle fillip be given to the needle, then since the time of oscillation varies as the square root of the strength of the field, by counting the oscillations, the strength of the field may also be investigated. Or, as in fig. 5, the field may be strewn with iron filings. This shows that when a ring is placed in a magnetic field the ring screens the space inside it, and the lines of force, instead of traversing the space inside the ring, for the most part divide and flow through its interior. But, of course, to allow of this the ring must be of a certain size to give them a passage wide enough to pass; otherwise, if the ring were too thin, they would be jostled out and compelled to take the path they did not prefer, namely, to go through the air space in the centre of the ring.

Now, let a coil of wire be supposed to slide round upon the ring, as shown in fig. 6. Then, as it does so, the lines of force passing through it will be very many, for the iron ring has drawn them all in and compelled them to thread the coil. Hence the effect in producing currents will be the same as in figs. 3 and 4, only greatly intensified, and the current direction will be changed at P and Q. If, instead of four isolated coils, we cover the whole ring with a series of continuous coils of wire, then in the passage of each portion from P to Q a current in one direction will be produced; but, as the portion goes from Q to P, a current in the other direction will be produced. Hence there will always be two currents flowing on opposite sides of the ring from P to Q. These currents would meet at Q, and neutralise one another. To prevent this, brushes or collectors are placed at P and Q, and each wire of the coils or certain wires at short intervals are scraped bare so as to come in contact with the brushes as the coils rotate. The two confluent streams then meeting, and having great energy stored up in them, which they must expend, rush like confluent streams of water into the brush at Q, traverse the external circuit, and re-enter the ring at P. Here then we have the action of the Gramme ring. According to this view the

parts of the wire which are inside the ring at first sight appear to be "idle coils," that is, either to cut no lines of force at all or else to cut lines of force traversing the centre of the ring, and thus, so far as they act, tending to produce currents in the reverse direction to the currents produced by the outside portions of the coils. If the ring is very wide, as in the Maxim dynamo, this will be so; but, if the ring is narrow, then the lines of force will curl in from the outside (as may be seen by the use of the compass, or filings) and will form the sectional diagram shown in fig. 7.

The position assumed for the brushes is at the points P and Q. But in practice it is found necessary to give them a "forward lead." This is due to the fact that directly a current begins to flow through the coils on the ring, the field of magnetic force is much modified. Poles are formed at P and Q, and by an examination of the direction of the currents it will be found that the current always tends to form at the point of contact of the brushes a pole similar in nature to the pole which the portion of the ring opposite the brush is approaching.

The effect, therefore, will be as shown in fig. 8. The lines of force from N will be repelled from Q and attracted in towards P. So that we shall now have the neutral points of the ring thrown forward to P^1 Q^1, at which points the directions of currents generated in the coils will change. The lines of force traversing the vacant space in the interior of the ring will likewise be modified and thrown rather more towards the neutral points. For they will now be the resultants of the poles N and S of the field-magnets, and the poles on the ring at P and Q. In fact, lines of force which quit N and enter the ring at M will divide into two streams. As the stream which takes the path M Q^1 Q R proceeds, more lines flow into the ring between M and Q^1, and thus many lines of force are thrust out across the ring and enter it on the opposite side, taking the positions vacated by the lines which quit the ring between P^1 and R.

Therefore, to gather the greatest amount of current we must now shift our brushes nearly to P^1 and Q^1.

The lines above mentioned may be rendered visible by winding the ring shown in fig. 5 with wire and sending a current through it from a battery, when the iron filings take up the positions shown in fig. 9. On this theory it will be seen, (1) That in a *narrow* Gramme ring there is hardly a single part of the interior portions of the coils which is really idle. For from Q^1 to M and P^1 to R the curling-in tendency of the lines of force shown in fig. 7 tends to utilise the coils which are passing, and from M to P^1 and R to Q^1, both the inside and outside of the coils are producing currents in the same direction round the coils.

(2.) That the principal work in producing currents is done in those quadrants of the ring which are immediately approaching the brushes and nearest to them.

The self-inductive effects of the reversal of the currents are of course considerable and play an important part, aiding the action of the coils.

The manner in which a Gramme ring acts has been the subject of controversy and of many valuable letters in this and in contemporary journals. If the above theory be correct, it affords a simple method of explaining this rather difficult matter to workmen and others unversed in mathematics.

Overhead Wires.—At a recent meeting of the Wandsworth Board of Works a letter was submitted from the secretary of the United Telephone Company, relative to the order of the board for proceedings to be commenced against that company for the purpose of removing some overhead wires which have been erected by them at Putney, stating that "the action of the board will tend to deprive residents in the district, who have offices in the City, of telephonic communication, it being impossible to conduct it by underground wires on account of the earth currents, and stating that they think that before taking legal proceedings the board should let their constituents know that at present there are no means known by which wires can be placed underground with satisfactory results." The matter was referred to a committee. The St. Olave's guardians, on Thursday, the 31st ult., refused permission to the United Telephone Company to erect a pole on Parish Street Workhouse at an annual acknowledgment of one guinea.

ELECTRIC LOCOMOTION—LIMITATION OF SPEED.

By ROBERT SABINE.

THE available work of an electro-motor set to actuate any locomotive system would be expended in (1) accelerating the train; (2) the rolling pull; (3) adhesion of the contacts; and (4) resistance of the air.

The work expended in acceleration would probably in practice with an actual line fall out of consideration, because the lines entering stations would certainly be provided with inclines for retarding the trains before arresting them, and these or similar inclines would be taken advantage of to accelerate the outgoing trains at the expense of the work stored up in stopping them instead of at the expense of the current. The rolling pull with a well-constructed electric train should not exceed that of a railway train; but when the current is on the motor there will be a drag caused by adhesion of the contacts slightly increasing the apparent rolling pull. On a level road it is probable that these two items might amount to 10 lb. per ton. When a certain speed is exceeded the heaviest item is the resistance of the air. When a flat vertical surface is set up at right angles to the direction of the wind the pressure upon it is directly proportional to its area, and also to the square of the velocity of the wind. The same rule holds good if the air is still, and the flat vertical surface is moved forward with the same velocity.* When the velocity is ten miles an hour, the air-pressure upon each square foot standing normal to the direction of the motion is only $\frac{1}{2}$ lb. But at a speed of 50 miles an hour—that of an express railway train—the pressure upon each such square foot is $12\frac{1}{2}$ lbs. And if the speed could be increased to 150 miles an hour, the air-pressure per square foot would be 1 cwt., while a speed of 200 miles per hour would have to be attained against an air-pressure of nearly 200 lb. per square foot.

This air-pressure multiplied by the number of feet through which the train travels in one minute gives the foot lbs. of work required to overcome the air-pressure. In the following table this is given in the last column in horse-power.

Speed in		Horse-power for air-pressure per square foot of effective surface.†
Miles per hour.	Feet per minute.	
10	880	0·01
15	1,320	0·04
20	1,760	0·09
25	2,200	0·18
50	4,400	1·5
75	6,600	5·0
100	8,800	11·8
150	13,200	39·6
200	17,600	94·0

We see, therefore, that with a train presenting a flat face and running at a speed of 50 miles an hour the air resistance absorbed per square foot would be 1·5 H.P.; at 100 miles an hour it would absorb nearly 12 H.P.; while at 200 miles an hour it would absorb 94 H.P. per square foot.

Now, of course, a train intended to run at a high velocity would not be provided with a butt end, which would be the worst possible form to travel quickly; but it would be

* The formula is

$$P = K w \frac{A v^2}{2g} \text{ lbs.}$$

in which

P = air-pressure in lbs. on the flat surface.

K, an empirical constant. For small surfaces about 1·75, and for larger surfaces up to 3·0.

w, weight of 1 cubic foot of air (= 0·0753 lbs.) at 20° C., at mean atmospheric pressure.

A, the area of the flat surface in square feet.

v, the velocity of motion in feet per second.

g, the acceleratrix = (32·2).

† Formula:—

$$\text{H.P.} = 1{\cdot}72 \times 10^{-11} \text{ A } v^3 \text{ (nearly).}$$

Assuming K = 1·75.

v being the speed in feet per second.

tapered off to cut through the air with the least possible resistance. But it would probably not be possible to taper this so much as to make the resistance of the air less than equivalent to that of one square foot of flat surface. Assuming this to be the case, we should have to arrange the motor to provide a spare $1\frac{1}{2}$ H.P. for air-resistance if driving at 50 miles an hour, which might be convenient enough; but I doubt whether the extra 12 H.P., which would be necessary to be provided for driving at 100 miles per hour, might not, even with the best of the present motors, entail considerable difficulty, whilst the extra 100 H.P. for air-resistance with a speed of 200 miles an hour would be out of the question altogether.

ON THE DEFORMATION OF POLARISED ELECTRODES.

By M. GOUY.

THE experiments which I am about to describe show a mechanical effect produced by polarisation upon solid electrodes, which may perhaps be approximated to the variation of the capillary constant of mercury, discovered by M. Lippmann. This phenomenon consists in a flexion which the electrodes undergo when polarised, if formed of a slender plate of metal protected on one of its surfaces by a very slight layer of an insulating varnish.

This deflection has been studied by two methods slightly different, which I am about to describe, taking as an example experiments made with gold and a saturated solution of sulphate of copper containing a little sulphuric acid.

1. From a piece of sheet gold of 0·015 mm. in thickness we cut a slip of 2 mm. in width, ending in a narrow point, which is then varnished upon one of its surfaces and fixed in a slip which leaves one of its ends free for the length of 0·06 m. This end is placed vertically and entirely immersed in the solution contained in a trough with parallel sides. The point is viewed with a microscope. This band is connected with the positive pole of a Daniell element; the other electrode of copper is connected to the negative pole.

Under these conditions the slip of gold is polarised without persistent electrolysis, and without the escape of a bubble of gas. The point occupies a determined point in the field of the microscope. We open the circuit and the point is gradually displaced, at the same time as the polarisation disappears. The circuit is closed again, and the point returns to its original position. The circuit is re-opened, and the two electrodes joined by a metal wire. The point springs abruptly to another position, where it remains. The direction of the displacement shows that the slip is bent away from the side not varnished; its absolute value is 0·1 mm. and its apparent magnitude 0·02 mm. On re-establishing the circuit as at first the point returns to its former position, and the same phenomena may be reproduced indefinitely. The displacements are sudden; they begin at the very moment when contact is made, and are complete in less than a second, without any oscillation. If we introduce into the circuit a great resistance (10,000 ohms) the displacements become a little slower, and reach in about 10 seconds three-fourths of their primitive value.

2. From the same sheet of gold we cut a slip 1·5 mm. broad and 0·60 m. long; it is varnished on one surface, and coiled up so as to form a helix of 4 mm. in diameter. This helix is placed vertically in a test-tube full of the solution; its lower extremity is fixed to the bottom of a weight, and a gold wire is joined to it to conduct the current; its upper extremity is supported by a very fine metal wire and supports a small mirror which sends an image upon a graduated scale.

With this apparatus we repeat the same experiments as with the former. Here the flexion of the slip coils or uncoils the helix according as the varnished side is without or within. When the polarisation changes suddenly, we see the image if thrown to a great distance describe some rapid oscillations, and become fixed in a new position of equilibrium. Its angular displacement is about 5° under the above conditions. It agrees well in direction and magnitude with the results of the former experiment. But the introduction of a great resistance in the circuit retards the phenomenon more, the surface of the electrode being here much greater.

Neither with this nor with the former apparatus are there any sudden displacements if we deposit upon the gold plate a very small quantity of copper. As soon as the copper is dissolved the electrode is polarised, a rapid deformation is produced and the apparatus acts as it did at first. This experiment should be made with a resistance of some hundreds of ohms, otherwise the galvanic deposit would occasion deformations of another kind, so rapid as to complicate the phenomena.

The deformations accompanying polarisation have been observed in acidulated water, and in various solutions with gold and platinum for the positive polarisation, and with these metals and silver, copper, brass, lead and tin for the negative polarisation. They vary in direction and extent between very wide limits. Gold, polarised positively in nitrate of manganese gives enormous deformations, at least 200 times greater than those just indicated. It is necessary to mention deformations of another kind which are produced when there is a deposit of metal upon the electrode or when a deposit already formed is attacked. These are gradual, increasing up to very wide limits, and are very rapid when the circuit has little resistance (several degrees of tension per second at the outset with a Daniell element and the gold helix described above). These flexions are evidently due to the mechanical action of the galvanic deposits which have been already studied by other methods. It is particularly interesting to examine how they agree with those produced by polarisation alone, *i.e.*, to study the period of transition during which the deposit begins to form or finishes disappearing.—*Comptes Rendus.*

ATLANTIC SUBMARINE TELEGRAPHY.

IN an article upon Submarine Cables, of March 30th, 1883, says the *Montreal Shareholder and Insurance Gazette* of May 18th, 1883, we invited Mr. Frederic Newton Gisborne to submit any additional evidence at his command in support of our declaration that to himself belonged the sole credit of having originated trans-Atlantic submarine telegraphy. That gentleman has responded by forwarding to us the annexed copies of certain letters in his possession, and we may add that the public records and leading articles which appeared in the newspapers of the day, 1850-51, coincide exactly with them. The communications in question were addressed to Mr. Gisborne respectively by the late Hon. Joseph Howe, then Colonial Secretary for Nova Scotia, afterwards Secretary of State for Canada and Lieutenant-Governor of Nova Scotia; and by Mr. John W. Brett—the latter being the submerger of the first European submarine cable between Dover and Calais, in 1851, while Mr. Gisborne himself submerged the first American submarine cable between Prince Edward Island and New Brunswick, in 1852. Such evidence appears to be complete and unassailable, not a link in the chain being wanting. We therefore now leave all question as to the originality of conception and the practical initiation of the most important enterprise of its day, to the impartial judgment of the world at large:—

From the Hon. Joseph Howe, *Colonial Secretary of Nova Scotia, in* 1848, *and afterwards Secretary of State for Canada, and Lieutenant-Governor of Nova Scotia, to* Frederic Newton Gisborne, F.R.S.C., *Engineer and Electrician, and at present* (1883) *Government Superintendent of the Telegraph and Signal Service, Dominion of Canada.*

My dear Gisborne,—Without desiring, in the slightest degree, to undervalue the services rendered to civilisation by the body of eminent men who have just been rewarded for laying the Atlantic cable, I own to some feeling of disappointment in not seeing any mention made of your name, as I have reason to believe you were the first pioneer of the enterprise, as well as the original promoter of electric telegraphy in the Maritime Provinces.

In the winter of 1848 you came to Halifax and interested the Government, of which I was a member, in the subject of telegraphic communication. A bill was introduced, and £4,000 was expended by the Government for construction of lines to connect Halifax with New Brunswick, Canada, and the United States. When that line was completed, you were employed to manage it under a Commission, of which I was the chairman, the Hon. George Young and William Murdoch, Esq., being the other members. This line was subsequently purchased from the Government by a company,

which has since extended branch lines to every shire, town, and seaport in the province. In 1850 you discussed with me, and subsequently laid before the Commissioners, a plan for connecting Newfoundland with the Continent of America, and obtained leave of absence to enable you to go to that island and secure support to the project. My brother Commissioners are both dead. On your return you asked leave of absence to go to New York to promote an extension of the line to England, and spoke confidently of being able to extend it across the Atlantic, and connect Europe with America. Up to this time I never heard the idea suggested, and, though reading the English and American papers, never saw any allusion to the practicability of such an enterprise. As no capital could be got in Halifax, you naturally sought in London and New York for co-operation and assistance. I do not, of course, know what took place abroad; but of this I have no doubt, that until you went to New York nobody had suggested or taken any steps towards promoting an Atlantic telegraph. As the original pioneer and projector of this great work, it appears to me that you ought to place yourself in your true position, and that, if not included among those who are to be honoured and rewarded, you should at least endeavour to obtain from your countrymen, and from the world at large, who are to be benefited, the recognition which you deserve as the originator and practical prime mover of the great enterprise now so happily brought, by a combination of public-spirited and able men, to a fortunate consummation. It ought not to be forgotten that the very line across Newfoundland, now used by the Anglo-American Company, was originally, at great pecuniary sacrifice and risk of health, explored by you and constructed by yourself as Chief Engineer of the New York, Newfoundland, and London Telegraph Company.

Believe me,
Very sincerely yours,
(Signed), JOSEPH HOWE.

London, 25, Saville Rowe, Feb. 12, 1867.

Extracts from Mr. John W. Brett's published letters to Mr. Gisborne :—

London, July 12, 1852.—"Major Carmichael Smith, a friend of your Hon. Mr. Howe, has just called and given me your plan."

London, May 26, 1853.—"Are you now prepared to co-operate in opening up telegraphic communication between Newfoundland and Ireland?"

London, July 8, 1853.—"On my return from Paris I found your satisfactory letter of 4th June. Let me recommend you to secure in our joint names an exclusive privilege for establishing a submarine telegraph between Newfoundland and Ireland for 50 years."

London, April 21, 1854.—"I should be glad, therefore, of a line from you stating clearly whether, as agreed, this is to be carried out between us as Brett & Gisborne's Atlantic Telegraph here and *vice versâ* in America."

From the above it is manifest that Mr. Cyrus W. Field and his associates could not have become interested in Mr. Gisborne's enterprise before the spring of 1854. This sustains us in our recent view that the pretension of Mr. C. W. Field to be the originator of this great project is simply preposterous. That astute gentleman, then as now ever ready to turn an honest penny, was about the date in question engaged in the development of the rag and waste-paper trade—an honourable career in itself no doubt, but not much calculated to "evolute" him into a great electrician.

SIR JAMES CARMICHAEL, Bart.

THE funeral of Sir James Robert Carmichael, who died on Thursday of last week, and whose death we recorded in our last issue, took place at noon on Tuesday, the place of interment being the Great Northern Cemetery, Colney Hatch. The body was incased in a lead shell, the outer coffin being of English oak with solid brass mountings and brass plates, and on the lid were the monogram of the deceased, a Maltese cross, and the following inscription: "Sir James Robert Carmichael, Bart., died 7th June, 1883, aged 66." The *cortège* started from the residence of the late baronet, 12, Sussex Place, Regent's Park, about eleven o'clock. The coffin, which was covered with a silk violet pall, with a white cross, and on which were numerous wreaths, was conveyed on an open car drawn by four horses, and was followed by four mourning coaches and four private carriages. The mourners included Sir James M. Carmichael and Miss Carmichael, son and daughter of the deceased, General Carmichael Smythe, General Forrest, Captain Forrest, and Mr. and Mrs. Lionel Tennyson.

At the cemetery the funeral was joined by a large number of the friends of the late Sir James, who had travelled by rail from King's Cross and thence by private carriages to the place of burial. Among these were Sir Algernon Borthwick, Sir Charles Bright, Sir Samuel Canning, Sir Julian Goldsmid, Mr. Childers, M.P., Chancellor of the Exchequer, and representatives of the various departments of the Submarine Telegraph Company, of which the deceased was chairman. In the chapel at the cemetery the funeral service was read by the Rev. Mr. Morris Thomas, of St. Mary's, Spital Square, and a hymn sung by the boys and other singers from the Chapel Royal, Savoy, another hymn being also sung at the grave.

The death of Sir James Robert Carmichael, Bart., the chairman of the Submarine Telegraph Company, deserves more than a passing notice. So many persons have claimed to be the originators of the submarine telegraph that we desire to give a few facts concerning the same. About the year 1845 Sir James Carmichael became acquainted with Messrs. Jacob Brett and John Brett. These gentlemen had some time previously been convinced that it was possible to insulate a wire, submerge the same and convey messages for any reasonable distance under water, and they patented their invention in England and France. Sir James Carmichael became interested in the scheme and agreed to give all the assistance in his power to help Messrs. Brett to carry out their project. They applied first to the Minister of Finance of the French Government for privilege to lay a submarine cable between Dover and Calais, which was granted. The time allowed having expired, the privilege was subsequently renewed by the Emperor of the French, then President of the Republic. An experimental cable, consisting of a copper wire covered with gutta-percha, coiled on a drum, was taken out in a small steamer and submerged between Dover and Calais, and one message was passed through the wire at the close of the day. The following morning the wire was grappled by some fishermen on the French coast, and, on its coming to the surface, not knowing what it was, they cut it, and so ended the the first submarine line.

Messrs. Brett, having thus become perfectly satisfied of the feasibility of submarine telegraphic communication, started a company for raising capital and laying down permanent submarine communication between England and France. Sir James Carmichael joined in the project as chairman of the company. The company was advertised, but the public, who looked upon the whole scheme as chimerical, did not subscribe, and it then fell through. Afterwards the question arose—could parties be found who had sufficient faith in the future of the scheme to subscribe the necessary capital? The matter remained under discussion for some considerable time, and on the 19th day of July, 1851, a meeting took place at the house of Mr. Brett, 2, Hanover Square, when Sir James Carmichael and seven or eight gentlemen agreed to make themselves personally responsible for the money requisite to manufacture and lay the cable. The question then arose where to find a contractor. The great engineers of the day had pronounced the thing impossible, but Mr. Thomas Russell Crampton, C.E., came forward, and not only undertook to manufacture and lay the cable, but also to find a considerable amount towards the cost. An agreement was signed with Mr. Crampton to that effect, and that gentleman at once proceeded to take the necessary steps to carry out his contract.

Referring to the completion of the event, the *Times* newspaper, in its article on the day following, used these words :—"The jest or scheme of yesterday has become the fact of to-day. The wildest exaggeration of an Arabian tale has been outdone by the simple achievement of modern times. The consequences of the electric telegraph must be as important as the agency by which they are obtained is wonderful. . . . In the case of the submarine electric telegraph the first and obvious effect of this instantaneous communication between the two most civilised and powerful nations of the world will be to unite them so closely in community of interest as to secure their co-operation in all business that may promote the advancement of humanity and maintain the peace of the world."

Such are the origin and facts connected with the invention and establishment of the first submarine telegraph. The original cable is still in existence between Dover and Calais. It has been many times repaired in consequence of breakage from ships' anchors, &c, but the portions of the core which are brought up from time to time are almost in as good condition as when first laid down. Sir James

Carmichael continued to be the chairman of the Submarine Telegraph Company to the day of his death (about 36 years). The company subsequently laid down other lines to the continent, and is most prosperous, paying dividends at the rate of 18 per cent. per annum.

The following we extract from the *Morning Post* of June 9th :—

As Chairman of the Submarine Telegraph Company especially, though he was connected with other similar enterprises, he became specially known some 30 years ago as one of the pioneers of the marvellous invention which has now placed a girdle round the world. Yet, so few years since, Sir James and his colleagues met with ridicule, even at scientific hands, when they first sought and failed to lay a cable across the Channel. But they tried again, owing not a little to the kindly sympathy and aid of the then Prince Louis Napoleon, President of the French Republic. The undertaking, at last, after long and arduous difficulties, succeeded, and its success brought further encouragement from the Emperor of the French, who was an earnest supporter of scientific progress, as was also Lord Palmerston, though the latter, after the success of the Channel cables, on prophesying that the day would arrive when we should communicate with India by telegraph was loudly laughed at in the House of Commons. Now every ocean is seamed with cables, and the lines of the Submarine Telegraph Company, under the guidance of Sir James Carmichael, traverse the Channel in every direction. Under his chairmanship the difficult question had to be encountered of how to make the new effort pay, and after a first and qualified success he, with his colleagues, had to accept onerous terms, which for a year or two deprived the enterprise of any dividend. But their faith in the sterling worth of the enterprise was ultimately well rewarded. Dividends were not only paid but rapidly increased until they verged on 20 per cent., and the £100 share, which at one time could have been obtained under £50, was sought for at £250. To this great result the untiring assiduity and clever diplomacy and earnest work of the chairman directly led. Sir James was essentially a man of high character, and in the many negotiations which he undertook his refined and gentlemanlike qualities tended greatly to the success which he achieved for his shareholders, for whom he fought many an earnest battle that he would never have undertaken for selfish objects. His life was thus passed in the public service. Born on the 11th of June, 1817, he was within a few days of completing his 66th year. When he began his public enterprise he was already mature in judgment, and up to the last he showed scarcely any sign of failing. His spare figure was never bent by age, and up to a short time ago he was unremitting in work. While he commanded respect and regard from all who came in contact with him, he inspired in his colleagues and *employés* a sincere and lasting affection, based at once upon the cordiality and nobility of his nature. By those who knew him best his memory will ever be cherished as that of a highminded gentleman, a true friend of open hand and generous heart.

Sir James Robert Carmichael, Bart., was the only son of General Sir James Carmichael Smythe, first baronet, by Harriet, only child of General Robert Morse, R.E., born on June 11th, 1817. He succeeded his father in 1838, and married, in February, 1841, Louisa Charlotte, daughter of Sir Thomas Butler, eighth baronet, by whom he leaves a son, James Morse, born in July, 1844, and a daughter, May. The first baronet, who had been Governor of the Bahamas, British Guiana, &c., received the title in 1821 for military services, having been aide-de-camp to King George IV. when Prince Regent, and having served on the Duke of Wellington's personal staff at Quatre Bras and Waterloo.

NOTES.

Erratum.—In the last sentence of Mr. Munro's letter in our issue of May 26th, the microphone discharge should be read as "continuous" not discontinuous.

Electric Lighting.—San Francisco is about to adopt electric street lighting. The California Electric Light Company offers to take the first contract to light a district at present having 1,700 gas lamps of 16 candle-power—27,200 candle-power, costing $77,350 per annum. It proposes to light the same by 210 electric lamps of 2,000 candle-power each—420,000 candle-power, for $65,520.

"An Old Electrician," in a letter to a contemporary on the subject of the electric light in Newington, states emphatically that any incandescent system of electric lighting put forward as a successful competitor against gas upon a commercial basis, is a direct fraud. It would really seem that a clique in the vestry has an interest in the proposed expenditure of £20,000. Surely, he says, some means can be adopted to stay these speculative gentlemen before the parish are committed to this prematurely unwise step, as it can only end in putting cash in the pockets of some obscure company desirous of getting a cheap advertisement and a show in London ; while the promoters will assuredly have to view with mortification the failure of their pet, financially and practically, as electric lighting exists at the present day.

In the House of Commons on Tuesday, on the motion of Mr. John Holms, two bills were introduced confirming Provisional Orders made by the Board of Trade under the Electric Lighting Act, 1882. The first bill related to Barton, Eccles, Winton and Monton, Carlisle, Croydon, Luton, Margate, Nelson, Rochester, Scarborough, and Sudbury ; and the second bill to Bermondsey, Clerkenwell, Hampstead, Holborn, Hornsey, St. George's-in-the-East, St. Giles's (Brush), St. James's, and St. Martin's London, St. Luke's, and Wandsworth. A bill was also introduced by the hon. member last week confirming Orders relating to, among other places, Canterbury, Folkestone, Gravesend, Greenwich, and Maidstone.

A Provisional Order has been granted by the Board of Trade to the South Staffordshire Electric Light Company of Birmingham to supply Wolverhampton with electricity. The capital of this company is £20,000, and of this sum £15,000 is to be set aside for the undertaking, half of the amount being deposited as security. Operations may be begun so soon as the company wish, after the necessary five weeks' notice has expired.

The Maxim-Weston Electric Company, Limited.—We are informed that the letters of allotment of the new issue of shares were posted on the 12th instant. It is said that friends of the management have applied for 27,500 shares at 5s. each. The market quotation for the original stock on the 13th instant was $\frac{1}{8}$ to $\frac{3}{8}$, as will be seen by our list of quotations published in this issue. This company has secured the lighting of the entire buildings of the Welsh Eisteddfod National Gathering.

The Duplex Electric Light Company.—We read that the British Trading Company has presented a petition for winding-up the Duplex Electric Light, Power and Storage Company, Limited, and Saturday, the 23rd inst., is fixed for the hearing, before Vice-Chancellor Sir James Bacon.

Conflicting Opinions on Underground Wires.—Mr. C. H. Haskins, a Milwaukee electrician, informs Chicago men, says an American contemporary, that he has examined the underground system in England and he does not consider it "feasible." On the other hand, Mr. Preece, the government electrician, and Mr. Fleetwood, of London, take a totally opposite view. Somebody must be wrong.

Engines for Electric Lighting.—C. H. Brown & Co., of Fitchburg, Mass., report a number of orders on hand, among them one from the Chicago Electric Works for a 350 horse-power engine. The Fitchburg Steam Engine Company has recently furnished a 150 horse-power engine for the Electric Light Company, of Fitchburg, Mass. The Cummer Engine Company, of Cleveland, is building a 500 horse-power engine for the Brush Electric Company of that city.

Desperate Encounter on a Train.—The passengers by the night train from Paris to Dieppe on Tuesday of last week witnessed a most exciting struggle. In 1881, Mr. Hiram S. Maxim, the electrician, was robbed of ten thousand francs while at the Grand Hotel, Paris. One of the thieves was a tall, stout man, calling himself an American naval captain ; the other was a smaller man, and was supposed to be Irish. Mr. Maxim determined to find out the men and bring them to justice, and, after being several times baffled, has now succeeded in arresting one of them. Mr. Maxim, in an account of his exploit to the daily press, says he learned that the supposed naval officer was named Jack Hamilton, and that he had acted as second to John C. Heenan, in the great international prize fight between Heenan and Sayers, and that the other man's name was John Palmer, a racing sharper and thief, passing himself off as an Irish lord. He continues : On the evening of the 5th inst. I left Paris for London, *viâ* Dieppe and Newhaven. Upon the arrival of the train at Rouen I alighted, and noticed a group of five Englishmen standing at the refreshment bar. Two of these I at once recognised as the men who had robbed me.

Without delay I seized upon John Palmer and called for the police. Before a policeman arrived the four others had entered their carriage, and the train started. When the train had got up a fair speed Palmer, whom I held, made a tremendous effort, slipped out of his coat, leaving it in my hands, and rushed for the departing train. I pursued him, and, gaining on him, caught him just as he got on the foot-board. He made a desperate attempt to throw me under the carriage wheels or beat me off. I succeeded, however, in gaining a firm foothold, and, passing one arm through a window, I held on to the thief with the other hand. Many passengers looked out of the window and screamed. The great confusion caused a signal to be given to stop the train, and when the speed was sufficiently slackened I jumped off the footboard, dragging my prisoner with me. Upon being taken before the Chief of Police he pleaded guilty, and will probably soon be brought to Paris for sentence. The only injuries which I received during this fierce and protracted encounter was the turning back of three of my finger nails, and tearing the sole from one of my boots.

Gas v. Electricity.—In the course of an inaugural address to the members of the Gas Institute, at Sheffield, on Tuesday morning, Mr. Paterson, of Cheltenham, the president, said Parliament had invited electricians to lay siege to them. They must, however, expect to meet a well-equipped stubborn foe, for the gas engineers would not voluntarily yield an inch to them. They wished electricians no ill, but gas must ever remain the best and cheapest light for the homes of England.

The Telegraph Convention.—The Siamese Government has notified its adhesion to the International Telegraph Convention.

Transatlantic Cables.—A company has been formed at New York, it is said, to lay two new transatlantic cables.

Vienna International Electrical Exhibition.—Besides the announced participation of the Danish naval administration in this exhibition, the Danish War Department will exhibit field telegraphs. Several Danish exhibitors have lately sent in their applications, one of whom, Francis Lund, chief of the department for submarine mines and torpedoes at the arsenal in Copenhagen, has been appointed by the Danish Government as official representative of the exhibitors. He is staying at present in Vienna, in order to consult and arrange with the managing committee all details respecting the Danish Exhibition, which, according to his estimation, will occupy an area of 190 square mètres.

Ball's Dynamo-Electric Machine.—Our readers will remember the two articles which we devoted a few weeks since to Ball's so-called "unipolar" dynamo. We expressed a very favourable opinion on the work done by this machine, and a series of tests which we afterwards carried out—using different instruments and methods on each occasion—fully confirm the report of Mr. Robert Sabine and our own just appreciation of the merits of the apparatus. We intend to publish our results shortly, but at present we only recall the subject for the purpose of reproducing portions of a letter written by Mr. Ball to the *New York Electrical Review* of the 17th ult. The American scientific press criticised Mr. Ball's machine adversely—certainly without reason, and with but little technical consideration—with the result of bringing forth from the gentleman referred to the communication from which we extract the following. We must, however, say that Mr. Ball does not by his writing show himself possessed of a knowledge of even his own machine, and it would have been wiser on his part to have kept silent.

"A good invention will survive all adverse comments thereon, and, were it not for several extraordinary misrepresentations in reference to my unipolar dynamo-electric machine, I would have allowed all criticism to pass unnoticed. . . . . The criticism of the *Electrical World* on my machine is simply misrepresentation and theoretical bosh, as I can practically demonstrate. That the expert of the said paper is a mere theorist and book electrician, is quite evident from his articles on electric lighting, which contain nothing new, being nothing more than a rehash from other writings, and which I can say from experience will strand any inventor or electrical student, if closely followed. I owe my success to the fact that I have ignored the old theories in reference to the action of the ring armature and lines of force. . . . . I am prepared to demonstrate the importance of my unipolar discovery by making a competitive test with any bipolar or multipolar electric generator in the market.

"The New York *Electrician*, in referring to my machine, says: 'The arrangement shown also involves mechanical difficulties which must prove very serious. It will be observed that by presenting only one pole of the field-magnet to each armature, the armature is powerfully attracted toward the pole, and the whole strain of this attraction is brought to bear transversely upon the armature shaft.' The fact that not the least detrimental effect has been experienced with the armature shafts of any of the machines which have been in constant use in Canada for over two years, is sufficient evidence that the above opinion is of no account.

"Mr. Rankin Kennedy in a communication to the *London Electrical Review* of the 7th ult. says:—'That it can hardly be claimed as a discovery at this time in electrical advance, that one pole of a magnet can generate currents in a rotating Gramme bobbin.' Other writers have also endeavoured to claim that I have made no discovery by citing the experiment made by Faraday in which he employed a copper disc rotated nearer one pole than another, and also to the experiment in which he fastened the copper disc to one pole of a rotating permanent magnet. In both experiments very weak currents were, however, generated. It is quite evident that Mr. Kennedy and all other inventors have been ignorant of the fact that the best results are obtained in a ring armature when it is subjected to only one pole of a magnet. The electric generator devised by Mr. Kennedy in which he employs a ring armature with four pole-pieces as shown in the *London Electrical Review* of March 10, 1883, fully confirms his ignorance of the said fact, as it is the most unscientific machine thus far invented. Mr. Kennedy and also the expert of the *Operator and World* still further show their complete ignorance of the subject, the former by suggesting a ring armature in connection with two like poles, which he terms the true unipolar machine, and the latter by citing as an anticipation of my invention, the carbon regulating mechanism of the arc lamp devised by M. Tchikoleff, a Russian, in 1874, which consists of a ring armature employed as a motor in connection with two pole-pieces of like polarity, the magnets of which being in two parallel circuits. . . . I will add that it is the opinion of prominent patent experts who have thoroughly examined the matter that there is novelty in my invention, and that the broad claim of an armature with one pole of a magnet allowed me by the Patent Office is valid."

The Telephone in America.—We learn from American sources that the instruments turned out by the Bell Telephone Company, which averaged 5,000 a month last year, have increased to 6,000 a month this year, and in April, the best month in the history of the corporation, it was nearly 7,000.

Underground Wires in New York.—The Common Council of New York has given permission to the Western Union Telegraph Company to lay its wires under the streets of the city on the payment of one cent. per lineal foot of each street opened, and the giving of two wires for the city's use.

Telephonic.—At their last meeting, the Plans and Works Committee of the Dundee Town Council granted leave to the Dundee and District Telephone Company and the National Telephone Company to erect 21 new lines. Three of the circuits are to be worked by the *Dundee Advertiser*—one for the Exchange and the others for their branch offices at Broughty Ferry and Lochee.

From the *Colonies and India* we learn that subscribers to the proposed Georgetown Telephone Exchange are to be called upon to pay an annual subscription of 60 dollars, a sum likely, it is added, to debar many persons from becoming subscribers who would willingly avail themselves of the advantages of inter-communication.

Telephone Factories in the United States.—There are six telephone factories in the United States, each doing a prosperous business. In one alone orders have been received for 6,000 instruments in six weeks' time.

Cable Communication between Saigon and Tonquin.—At the French Cabinet Council a short time since, the question of laying down a cable connecting Saigon and Tonquin was discussed.

The Crystal Palace Electrical Exhibition.—Messrs Geo. Bray & Co. write to the *Leeds Mercury* under date June 4th as follows:

"The above-named exhibition, at which several firms in this district exhibited, has been conducted in so unusual a manner that we think public attention should be called to it, so as to prevent firms, who have a trade reputation that is worth an effort to keep, from encountering difficulties similar to those with which we have had to contend.

"The Crystal Palace Company announced, in a prospectus of the ordinary character, that the exhibition would be kept open until the end of the month of March, 1883. A few days before the time for closing, a circular was sent by the company to exhibitors asking them to allow their goods to remain a month longer. Many firms could not do so because of engagements to attend other exhibitions, and they accordingly removed their goods at the end of March, receiving an expression of friendly regret from the company. Up to this time no intimation had been given that exhibits would be tested and awards granted, and the surprise of those firms who had left may be imagined when, shortly after they had removed their goods, they received a circular from the company (dated April 2nd) stating that jurors had been appointed to test exhibits and grant awards.

"We, being amongst the number of the firms who had been unable to remain after the time for closing the exhibition, protested against awards possessing a competitive value being granted under the circumstances recited above; but our protest was unavailing. We therefore applied for an injunction to restrain the company from granting awards, but Mr. Justice Pearson ruled that the company in their prospectus had entered into no contract with exhibitors, consequently he would not grant an injunction. The above facts are not disputed by the Crystal Palace Company, yet we suppose they will still give the awards, and those awards will be accepted by the public as representing the relative value of the appliances shown at the exhibition. It is scarcely necessary to say that this obviously unfair mode of granting awards is unknown in connection with other exhibitions, and would have been impossible at our great International Exhibitions of 1851 and 1862.

"We therefore desire to be allowed to inform firms who may be invited to exhibit at any future exhibitions promoted by the Crystal Palace Company—firstly, of the course pursued by that company at their last exhibition; and, secondly, of the impossibility of obtaining legal redress for injustice of the kind described above, unless there be a contract of a more specific character than any contained in the usual prospectuses of exhibitions."

Cable Repaired.—Telegraphic communication with Valparaiso, Mollendo, Arica, Iquique, Autofagasta, Santiago de Chili, Buenos Ayres, and all telegraph stations in Peru, Chili, and the Argentine Republic is now re-established, *viâ* Galveston.

The Western Electric Company.—This company, manufacturing largely in America telegraphic and telephonic instruments, electric bells and other apparatus, has opened a London branch at 59, Moorgate Street, E.C.

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

Hammond Electric Light and Power Supply Company (Limited).—The annual return of this company, made up to the 23rd ult., was filed on the 11th inst. The nominal capital is £250,000, in 50,000 shares of £5 each, 25,000 of which have been taken up. Upon 17,980 shares the sum of £2 10s. has been called, and the full amount upon the remaining 7,020. The total calls paid amount to £80,050. Registered office, 110, Cannon Street.

China and Japan Telephone Company (Limited).—The first return of this company, made up to the 4th inst., was filed on the 11th inst. The nominal capital is £20,000, in £1 shares; 11,049 shares have been issued and paid up in full.

Telephone Company of Egypt (Limited).—The first return of this company, made up to the 4th inst., was filed on the 11th inst. The nominal capital is £100,000, divided into 16,000 preferred and 4,000 deferred shares of £5 each. Upon 12,000 preferred shares the sum of £5 per share has been called and paid; 4,000 deferred shares have been allotted, but no call has as yet been made in respect thereof. Registered office, 3, Great Winchester Street, E.C.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid	Closing Quotations. June 13.	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	7	3⅞ - 4¼	
		Do. Do.	10	6½ - 7⅜	
30,000	5	Australasian Electric Light, Power & Storage Co.	3	⅜ - ½	
24,900	10	British Insulite Co., Limited, "A" Shares	5	1⅝ - 2	
30,000	5	Brush Electric Light & Power Co. (Scotland)	2½	⅜ - ½	
25,000	5	Great Western Electric Light & Power Co.	2½	⅜ - ½	
24,980	5	Hammond Electric Light & Power Supply Co.	2½	2¼ - 2⅜	
40,000	5	Indian & Oriental Electrical Storage Works Co.	2	..	
172,500	1	Maxim-Weston Electric Light and Power Co.	1	½ - ⅝	
..	..	Metropolitan Brush Electric Light & Power Co.	3	..	
40,000	5	Pilsen-Joel & General Electric Light Co.	2	½ - ⅝	
..	..	South African Brush Electric Light & Power Co.	¼¼	..	
100,000	5	Swan United Electric Light Co., Limited	2½	1⅜ - 1⅝	
		TELEGRAPHS.			
2,116,400*l.*	Stk.	Anglo-American, Limited	100	50 - 51	
2,441,800*l.*	Stk.	Do. Preferred { Def'd. receiving no div. until }	100	82 - 83	
2,441,800*l.*	Stk.	Do. Deferred { 6 p. c. has been paid to Pref. }	100	20 - 21	20m.
130,000	10	Brazilian Submarine, Limited	10	11⅝ - 12	11⅞-12m.
16,000	10	Cuba, Limited	10	10 - 10½	10m.
6,000	10	Do. 10 per cent. Preference	10	17 - 18	
13,000	10	Direct Spanish, Limited	9	5½ - 6	
6,000	10	Do. 10 per cent. Preference	10	15⅝ - 16⅞	16½ 16m.
65,000	20	Direct United States Cable, Limited, 1877	20	12⅜ - 12⅝	
100,000*l.*	100	Do. 6 per cent. Debenture, repayable 1884	100	99 -102	
380,000	10	Eastern, Limited	10	10⅜ - 10⅝	10⅜m.
70,000	10	Do. 6 per cent. Preference	10	13 - 13½	13½m.
232,000*l.*	100	Do. 6 do. Debentures, repayable Oct. 1883	100	100 -102	
200,000*l.*	100	Do. 5 do. do. Aug. 1887	100	101 -104	
200,000*l.*	100	Do. 5 do do. Aug. 1899	100	104 -107	
199,750	10	Eastern Extension, Australasia & China, Limited	10	11⅞ 12	
50,250		Do. New Shares. 1883	8	8⅛ - 8⅜	8⅛a.
320,000	100	Do. 6 p. c. Debentures, repayable Feb. 1891	100	109 -112	
500,000	100	Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900	100	104 -107	
140,000	100	Do. do. registered, repayable 1900	100	104 -107	
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	102 -105	
254,300*l.*	100	{ Eastern and South African Limited 5 per cent. } { Mort. Deb. Registered redeemable 1 Jan. 1900 }	100	103 -106	
345,700*l.*	100	Do. do. do. To Rearer	100	103 -106	
22,050	10	German Union Telegraph and Trust Limited	10	10 - 10½	10½m.
163,390	10	Globe Telegraph and Trust, Limited	10	7 - 7¼	7¼ ¼ ¼m.
163,209	10	Do. 6 per cent. Preference	10	12⅝ - 13	12⅝.13.12⅝. 13⅜m.
125,000	10	Great Northern	10	12⅝ - 13	
100,000*l.*	100	Do. 5 per cent. Debentures	100	101 -104	102½m.
300,000	100	Do. 5 per cent. Debentures	100	101 -104	
31,200	10	India-Rubber, Gutta-Percha and Telegraph Works	10	30½ - 31	
100,000	100	Do. 6 per cent Debentures, 1886	100	105 -106	
17,000	25	Indo-European, Limited	25	31½ - 32½	
38,148	10	London Platino-Brazilian, Limited	10	3⅞ - 4¼	
12,060	10	Mediterranean Extension, Limited	10	1¾ - 2	
8,200	10	Do. 5 per cent. Preference	10	6 - 7	
9,000	8	Reuter's, Limited	8	9½ - 10	
280,000	Stk.	Submarine	100	247 -252	
58,225	1	Do. Scrip	1	2¼ - 2½	
4,200	Cert.	Submarine Cables Trust	100	105 -109	107m.
37,350	12	Telegraph Construction and Maintenance	12	33½ - 34½	34m.34a.
150,000	100	Do. 6 per cent. Bonds, 1884	100	101 -103	
186,750	5	Do. 2nd Bonus Trust Cert.	2½	1⅝ - 1⅞	
30,000	10	West Coast of America, Limited	10	4½ - 5	
150,000	100	Do. 8 per cent. Debentures	100	108 -110	
69,910	20	Western and Brazilian, Limited	15	6⅜ - 6⅝	6¼a.
		Do. Preferred	7½	5 - 5½	
		Do. Deferred	7½	1¼ - 1½	1¼m.1¼a.
		Do. 6 per cent. Debentures "A" 1910	100	108 -110	
200,000*l.*	100	Do. 6 p.c. Mort. Deb. series B of '80, red. Feb., 1910	100	100 -103	
2,500	100	Western Union of U. S. 7 p.c.1 Mort.(Building)Bds.	$1,000	122 -124	
1,500	$1,000	Do. 6 per cent. Sterling Bonds	100	103 -106	
1,030,000*l.*	100	West India and Panama, Limited	10	1 - 1⅛	
88,321	10	Do. 6 per cent. 1st Preference	10	6½ - 7	
34,563	10	Do. 6 do. 2nd do.	10	5 - 5½	
4,669	10				
		TELEPHONES.			
154,165	1	Con. Telephone & Maintenance, Ld. Nos. to 154,165	1	⅜ - ½	
200,000	1	Oriental Telephone Co., Nos. 80,001 to 300,000	½	⅜ - ½	
100,000	5	United Telephone Co.	5	10 - 10½	10½-10¾-11. 10m.10½a.

The Eastern Telegraph Company.—This company notifies that a steamer leaves Durban for Mauritius and Madagascar on the 22nd inst. Messages for the above ports intended for that opportunity should be handed in not later than noon on the 21st instant.

NEW PATENTS—1883.

2722. "Electric devices for indicating speed and for operating safety valves." R. P. SELLON. Dated May 31.

2739. "Apparatus for generating and utilising electric energy." A. J. BOULT. (Communicated by B. Faquant.) Dated June 1.

2741. "Electro-magnetic engines, electro-motors, and electro-generators." R. W. M. FRASER. (Communicated by J. R. Fraser.) Dated June 1.

2743. "Electric arc lamps." F. L. WILLARD. Dated June 2.

2763. "Apparatus for generating, distributing, regulating, and measuring electricity applicable for the purposes of illumination and for the conversion of electricity into motive-power." W. H. SCOTT. Dated June 4.

2768. "Method of and apparatus for generating electric currents, which apparatus may also serve as an electro-motor." H. H. LAKE. (Communicated by R. E. Ball.) Dated June 4. (*Complete.*)

2769. "Electric lamps and apparatus to be used in the manufacture of the same." W. R. LAKE. (Communicated by C. L. R. E. Menges.) Dated June 4.

2770. "Electro-motors." J. IMRAY. (Communicated by H. T. Hillischer.) Dated June 4.

2782. "Electrical wire protectors." J. O. COTTRELL. Dated June 5.

2786. "Electrical apparatus for igniting gas, the said apparatus, or portions thereof, being applicable for other purposes." J. A. KOERBER. Dated June 5.

2788. "Primary voltaic batteries." G. G. ANDRÉ. Dated June 5.

2795. "Electric bell apparatus." W. R. LAKE. (Communicated by La Société Dany et Lepage.) Dated June 5.

2800. "Electrical motor." W. PEEK. Dated June 5.

2804. "Generating, regulating, measuring, and distributing electric currents and electric energy." A. and T. GRAY. Dated June 6.

2817. "Electrical signalling and interlocking apparatus for railways." C. HODGSON. Dated June 6.

2822. "Apparatus for putting instruments connected with a central telephone station into communication with each other. W. R. LAKE. (Communicated by G. A. Cardwell.) Dated June 6.

2832. "Apparatus for connecting and disconnecting electrical circuits, and limiting and measuring currents passing through them." H. H. CUNYNGHAME, O. E. WOODHOUSE, and F. L. RAWSON. Dated June 7.

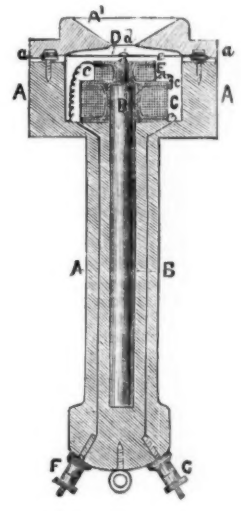
2850. "Construction and manufacture of electric incandescent lamps, in the regulation of electric currents, and in governors therefor, and for other purposes." W. J. L. HAMILTON. Dated June 7.

2855. "Electrodes used as earth-plates." D. G. FITZGERALD. Dated June 7.

2856. "Electrical generators and motors." W. R. LAKE. (Communicated by Mary Bollmann.) Dated June 7.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1882.

4778. "Telephones." H. B. T. STRANGWAYS. Dated October 7. 6d. The object of this invention is to increase the efficiency of telephones, whether used as transmitters or receivers, and it relates to the application to electric telephones of certain novel means for increasing the electric effect of the action of the diaphragm or other vibrators, and consequently the strength of the currents produced in and transmitted by the instrument; and for increasing the electrical effect of the varying currents upon the receiver, and consequently the volume of sound produced. According to the invention, the inventor uses two helices, but he sends a current in one and the same direction through both helices, and thus he acts simultaneously and in precisely the like manner upon the principal magnet and on the small magnet or piece of metal capable of inductive action, obtaining thereby the sum of the two actions. The result of this mode of applying the current is the production of larger electrical effects and louder sounds than were heretofore obtainable. The figure represents a longitudinal section of a telephone receiver of the ordinary type, arranged to suit the purpose of the invention. A is the telephone case, within the handle of which is fixed a permanent bar magnet, B, having as usual a helix or coil of insulated wire, C, wound around a bobbin, *c*, on its upper end, or that which is nearest to the diaphragm, D. To this diaphragm, D, which may be made of wood or metal, or any substance capable of rapid vibration, is attached, by riveting or otherwise, the small magnet or short bar of metal, *d*, capable of inductive action, and of such small size and weight as will not unduly check or impede the vibrations of the diaphragm or tympan, and of such small diameter that any transverse vibrations set up in such small magnet or piece of metal capable of inductive action shall not be of sufficient strength to deaden or destroy the longitudinal vibrations set up in or imparted to the said small magnet or piece of metal by the varying electric currents or by the vibrations of the diaphragm or vibrator. Though the dimensions may vary as the size of the other parts of the telephone, the inventor finds that a piece of iron wire, No. 9 B.W.G., from one quarter to three-eighths of an inch in length, answers admirably for this piece, *d*. This small magnet, *d*, is preferably rounded off or reduced in diameter at the part where it touches the diaphragm, D, to the smallest size consistent with its secure attachment thereto. The diaphragm, D, does not require to be attached to the case, A, all round its periphery, as is usual, but may rest upon the heads of three or more screws, *a*, *a*, which may conveniently for adjustment have shoulders, formed thereon to receive the circumference of the diaphragm and insure its exactly concentric position with respect to the case, A, the magnet, B, and the solenoids or helices in connection therewith, or it may rest upon the case in three or more places. Surrounding the small magnet or piece of metal, *d*, is a second helix, E, of insulated wire (the gauge known as No. 36 B.W.G. answers well), which is wound around a wooden bobbin, *e*, formed in one, or so as to be one, with the bobbin, *c*, on which the helix, *c*, is wound. The wire leading from the terminal, G, is wound so as to form the two helices, C and E, and it is then led to the terminal, F. These helices are so wound that the current will pass through both in the same direction. Instead, however, of passing the whole of the current through each helix in succession, the two helices may be connected with the line wires and the current split, sending one part through each helix; and if it is desired to further reduce the resistance of the helices, they or either of them may be wound with two or more wires, the current being sent through all in the same direction. The bobbin, *e*, of the helix, E, is accurately turned and drilled



at its centre to receive the small magnet or piece of metal capable of inductive action, *d*, attached to the diaphragm, D, and this hole is of such diameter as will just allow the piece, *d*, to reciprocate freely without touching the walls of the said bobbin, *e*. The diaphragm, D, is adjusted at such a distance from the pole, B^1, of the magnet, B, that the end of the small magnet, *d*, when the diaphragm is vibrating, shall be as close as possible to, though without coming in contact with the end of the magnet, B. The diaphragm, D, is held in place by the mouth or ear-piece, A^1, of the telephone case, which may be screwed down upon it so as to hold it all round, or so as to hold it in three or more places, and the concentric adjustment of the diaphragm may be effected by shifting its position with the finger nail, or otherwise, before finally screwing the mouth-piece down on the case, or securing the mouth-piece to the case by screws, or otherwise. It will be understood that on speaking into the mouth-piece, A^1, the diaphragm, D, will be caused to vibrate, and the consequent end-way movement of the piece, *d*, within the coils of the helix, E, and in close proximity to the polar extremity of the magnet, B, will have the effect of greatly increasing the electrical currents produced by the instrument and transmitted to the line wires. If, on the other hand, the instrument be used as a receiver, the variations in the electrical current passing through the line wire and around the coils, C and E, will cause the piece, *d*, to receive a rapid reciprocation endwise, corresponding to such variations in the current, and thereby set the diaphragm, D, in action.

4810. "Dynamo-electric machines." R. E. B. CROMPTON and G. KAPP. Dated October 10. 4d. Relates to improvements in dynamo-electric machines and more particularly to those dynamo-electric machines which are required to maintain a nearly constant electromotive force at their terminals where the external circuit is joined on, under extreme variations of the external resistance in the circuit worked by such machines. In the inventors' improvements they so wind the field-magnets that the electromotive force, or speaking more accurately the difference of potential between the terminals is maintained at one level throughout, *id est*, when the external resistance is low and the armature current correspondingly high. The heavy current passing through a thick wire, coils on the field-magnets excites them very fully. When, however, the external resistance is high and the armature current correspondingly low, then high resistance coils coupled parallel to the external circuit still continue to supply current sufficient to enable them to aid the excitation of the field-magnets to maintain the electromotive force practically constant as above described. The inventors call this winding of the field-magnets compound winding. One method of carrying out this compound winding is to take a dynamo-electric machine

having an armature resistance of, say, 0·1 ohm, and wind on to its field-magnets next to the core sufficient turns of No. 5 B.W.G. wire to give a resistance equal to that of the armature or 0·1 ohm, or thereabouts, and couple these coils in series circuit with the armature in the ordinary manner, outside these coils they wind on sufficient ·057″ wire to give a resistance of 20 ohms or from that to 30 ohms. They couple up this second winding of fine wire from brush to brush. Such an armature they prefer to drive at such speed that the electromotive force when the resistance of the external circuit is infinite will be about 65 volts. It will be found that if the external circuit be now closed through resistances varying from infinity down to 0·75 ohms, so that the current in the armature varies from 2 ampères up to 80 ampères, the electromotive force between terminals will remain nearly constant at the above-named 65 volts. Moreover, that the magnet charge or extra current of the short length of low resistance coils will be so small that 40 or 50 lamps may be switched instantaneously out of the main circuit without producing any momentarily hurtful increase of current in one lamp left in circuit. This compound winding of the field-magnets of dynamo-electric machines has the further advantage of reducing sparking and wear of commutator and brushes to a minimum, as it always maintains a due proportion between the strength of the fixed magnetic field and the distorting influence of the induced field of the rotating armature.

4816. "Voltaic batteries." E. J. WIMSHURST. Dated October 10. 2d. Has for its object to produce a battery at a small cost especially suited for domestic purposes, such as lighting or driving domestic machinery. The battery, constructed according to the said invention, consists of a portable box or casing for the vessels containing the plates or elements and liquid. The elements consist preferably of two carbon plates connected together by a strip carrying a screw, which projects through the cover of the box. This screw passes through a copper conducting strip constituting the coupling strip for two elements. A zinc plate is situated between the carbon plates and insulated from them by varnished wood or other non-conductor. A similar screw and nut forms the connection of the zinc plate with the copper strips. Each pair of elements is similarly arranged, and all the pairs are connected by the copper strips. The plates are capable of delicate adjustment to allow of a ready regulation of the power generated. To effect this a vertical screw projects from the cover which holds the elements and conducting strips, and this screw passes through a fixed cross-bar, and is furnished with a nut bearing on the said bar, by rotating which nut the elements are raised and lowered into the liquid with the greatest nicety in accordance with the power required. The current may be conducted from the battery in the usual manner, and utilised for lighting, driving, or other purpose as required.

4819. "Electric machines." W. R. LAKE. (A communication from abroad by J. Wenström, of Orebro, Sweden.) Dated October 10. The object of this invention is to utilise in dynamo-electric or magneto-electric machines the excited magnetism more completely than is done in such machines as heretofore constructed, whereby the inventor is enabled to reduce the quantity of the exciting current and the resistance in the circuit, and obtain the same result with less velocity and power, and thereby reduce cost of construction and maintenance. The said invention relates both to the field-magnets and to the armatures of the said machine. Fig. 1 is a vertical trans-

FIG. 1.

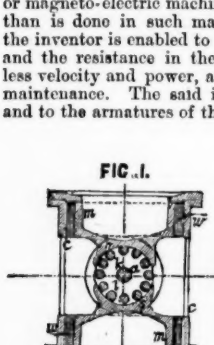


FIG. 2.

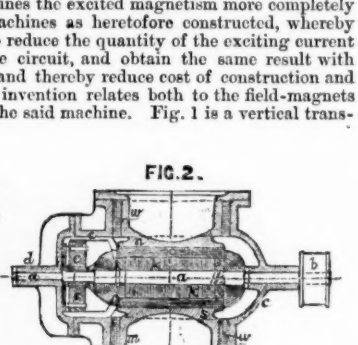
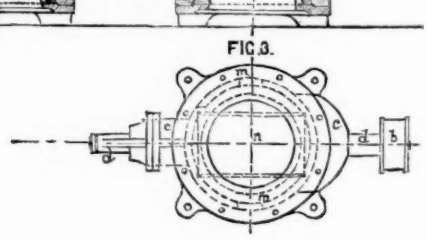


FIG. 3.



verse section, fig. 2 a longitudinal section, and fig. 3 a plan of a dynamo-electric machine constructed according to this invention. *c* indicates the frame of the machine; *d*, *d*, the bearings; *m m* the field-magnets; *w w* the insulated magnet-coils; and *n s* the magnet-poles. Between the said poles on the shaft, *a*, revolves the armature, which consists of the iron core, *k*, and the coils, *l*, in connection with the commutator, *f*, where the electric current is collected and returned by the brushes, *e*, *e*. *b* is the pulley for applying the force. The electro-magnets as heretofore employed generally consist of iron cores covered with wire. In magnets so constructed a large quantity of magnetism is excited round about them, and as this magnetism is not utilised great loss is occasioned. In magnets constructed according to the said invention the bulk of the wire is enveloped in iron, and the excited magnetism in all directions will meet iron capable of conducting it to the place where it is required. The said iron serves at the same time to firmly unite all the stationary parts of the machine, and allows the armature to move freely between the polar surfaces or extensions. In the arrangement shown in figs. 1, 2, and 3 the magnet coils, *w*, are enclosed between iron cylinders, *c* and *m*, which, with their extensions, form the frame as well as the magnet poles *n* and *s*.

4829. "Electrical switch for electrical lamps, &c." G. W. BAYLEY. Dated October 11. 2d. Consists of an electrical switch constructed in the manner especially suited to be used in connection with electric lamps, but may also be used for closing and breaking an electrical circuit for other purposes. (*Provisional only.*)

4832. "Telephones." J. H. JOHNSON. (A communication from abroad by Léon de Locht-Labye, of Paris.) October 11. 6d. This invention relates to improvements in telephones, and it consists in the employment for the purpose of communicating vibrations to a resisting body or diaphragm of a lever connected to an armature suspended before the poles of a magnet or electro-magnet as hereinafter described. The lever may be formed in one with the vibrating body or diaphragm, or may be provided with a hammer in contact with the said diaphragm. The oscillations of the lever, and the action of the hammer on the surface opposed to it, synchronise with or correspond to the movements of the armature when the latter is acted on by telephonic currents from a distant station circulating in the coils of the magnet, and in like manner when the telephone is employed as a transmitter, the vibrations of the diaphragm produce through the lever corresponding vibrations of the armature suspended before the poles of the magnet and like undulations in the current. The fulcrum or axis of oscillation of the lever may be situated either between or beyond the points at which the magnetic attraction or repulsion of the armature and the reaction of the vibrating body or diaphragm are applied.

4869. "Electric lighting." W. STRICKLAND. Dated October 13. 6d. The object of the invention is to produce a constant and perfectly steady arc of light without the use of any special regulating mechanism as in ordinary arc lamps, also to increase the time during which an arc may continue to run and to form by division a low resistance to electric motion within the lamp. For the purpose of the invention the inventor uses four carbon or conducting pencils to an arc, which are placed in suitable holders and passed between suitable guides to form two parallel (or nearly so) lines, the poles or points of each pair being in contact one with another, and maintained so while in action by gravity or other means.

4878. "Galvanic batteries." G. C. V. HOLMES and S. H. EMMENS. Dated October 13. 2d. Relates to improved means of diminishing the internal resistance and increasing the electromotive force and constancy of galvanic batteries, by modifications in the form of the electrodes and in the de-hydrogenising or depolarising fluids and substances hitherto employed.

4880. "Electric arc lamps." A. M. CLARK. (A communication from abroad by W. S. Parker, of America.) Dated October 13. Relates to the class of electric arc lamps in which the upper or positive carbon is controlled by a clutch actuated by one or more electro-magnets. Fig. 1 is a horizontal section of a lamp embodying the invention. Fig. 2 is a vertical section of a lamp with two regulating magnets. The lamp frame or case may be of any suitable form. On the

FIG. 1.

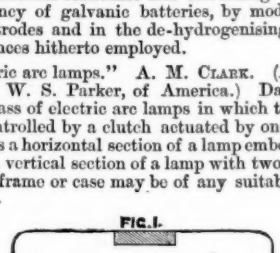
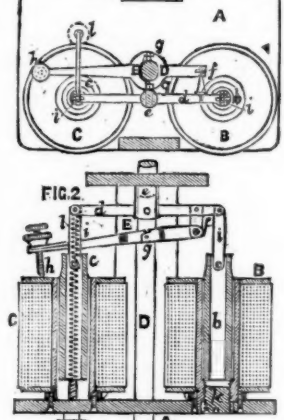


FIG. 2.



plate, A, are fixed the differential magnets, B C, the latter being the shunt magnet. Both magnets are of the axial type and are wound on tubular bobbins of soft iron containing hollow cores, *b c*, of soft iron respectively. These cores are suspended by jointed links, *i i*, from opposite ends of a lever, *d*, suspended on a support, *e*, above the magnets. D, is the carbon-holder, and E is the clutch hung at one end by a link, *f*, from the lever, *d*, above the lifting magnet, B. The clutch is made in two pieces each forked at one end, the forked ends being connected by knuckle joints, *g*, forming a jointed clutch through which the carbon holding rod, D, passes. In the outer end of the clutch bar a set screw, *h*, is fitted to bear on the magnet, C, so as to support the bar at that end. The end of the lever, *d*, supporting the core, *c*, of the shunt magnet, C, is connected to a spring, *l*, which tends to

draw that end of the lever down and assist the rise of the lifting core, B. The cores being suspended from opposite ends of the lever, are both simultaneously moved by increase or decrease of magnetism in either magnet or the combination forms a differential balance. The regulation of the normal position of the core of the lifting magnet, D, is provided for, by fitting in the lower end of that magnet a pole block, *k*, made as a screw plug that can be set in and out of the magnet. The action of the cores, lever and clutch mechanism, is due to the repulsive action of the cores and surrounding bobbins in this wise:—When the current becomes too strong by reason of contact of the carbons or shortness of the arc, the magnetism of the coil, D, is increased and the iron bobbin and core become polarised in the same direction which, upon a well-understood principle, results in the repulsion or upward movement of the core, *b*. This action of the latter tilts the lever, *d*, thus causing the clutch lever, E, to grip the carbon holding rod, D, and raise it so that the carbons will be separated and the arc elongated as required, and when such separation of the carbons has increased the resistance to the passage of the current to a sufficient degree, the branch circuit polarises the iron bobbin of the shunt magnet, C, throughout its whole length so that both ends repel the adjacent ends of the iron core, *c*, thereby moving the lever, *d*, back to the original position which causes a release of the clutch, E, and allows the carbon rod, D, to drop far enough to reduce the resistance of the arc to its normal condition.

4883. "Electric lamps." P. R. DE FAUCHEUX D'HUMY. Dated October 14. 6d. The invention has for its object improvements in that class of electric lamps known as incandescent lamps and relates to means whereby the destruction of the metallic or carbon filament is delayed or prevented for a considerable period and the necessity of employing costly and troublesome machinery and processes for producing a vacuum in the glass globe or bulb is obviated, whilst facility is afforded for cleansing and renewing the various parts of the lamp without the necessity for destroying any part thereof.

4884. "Electrical distribution, &c." T. J. HANDFORD. (Communicated from abroad by T. A. Edison, of America.) Dated October 14. 6d. The object of this invention is to so arrange the system of conductors supplying a district that the supply in the various localities of the district will be proportioned to the demand, and so that all the lamps throughout the district will have practically the same candle-power, all being within two or three candle-power of a standard.

4889. "Apparatus for the development of electricity." J. WHITLEY. Dated October 14. 4d. Relates to the casting or otherwise forming a solid helix or helices in copper, or other metal, or the alloys of metals, for the purpose of aiding in the development of electricity.

4911. "Electric lamps." J. ALLMANN. (Communicated from abroad by L. E. Schwerd and L. Scharnweber, both of Germany.) Dated October 16. 2d. Relates to that type of electric lamp wherein the attraction of the solenoid directly effects the regulation of the arc. (*Provisional only.*)

4915. "Switches for electric lamps." T. W. COWAN. Dated October 16. 6d. Relates to improvements in switches for electric lamps, whereby a lamp or a number of lamps can be lighted or extinguished at will after the manner in which gas lamps are lighted and extinguished.

4921. "Voltaic batteries." J. L. HENDERSON. (Communicated from abroad by A. Blondin, of France.) Dated October 16. 2d. Relates to a construction and arrangement of voltaic battery in such a manner as to provide great battery power in small compass and at little expense, and to effect in a simple manner the depolarisation by re-oxidation of the liberated hydrogen and the continuous supply of fresh exciting liquid and removal of the spent liquid. (*Provisional only.*)

4928. "Dynamo-electric machine." A. C. ELLIOTT. Dated October 17. 2d. Relates to an improved dynamo-electric machine, which may be used either to transform mechanical energy into electric currents or to convert electric energy into mechanical work. (*Provisional only.*)

4931. "Electric motors." A. G. DE NEEFF and E. DESFOSSÉS. Dated October 17. 4d. The improved motor consists of a frame supporting two induction bobbins united top and bottom by soft iron bars fixed to the bobbins by screws; these bars communicate with two others also of soft iron, between which a number of bobbins on the Siemens principle turn and are coupled at right angles so as to overcome the dead point.

4971. "Electric alarm apparatus for the detection of burglars, &c." M. H. KERNER. Dated October 18. 2d. Relates to electric alarm apparatus for the detection of burglars and for similar purposes. (*Provisional only.*)

4988. "Electric arc lamps. A. SERRAILLIER. Dated October 19. 6d. Relates to a novel arrangement of apparatus for feeding the carbons of arc lamps so as to maintain the brilliancy and steadiness of the light. The upper carbon, or it may be the lower, is inserted between a set of elastic grippers made fast to the frame of the lamp and a corresponding set of elastic grippers is carried by a horizontal plate which surrounds the carbon. By giving this plate an up and down motion its elastic grippers will alternately bite the carbon and force it between the fixed grippers and then slip back over the carbon to take a fresh grip.

4991. "Secondary batteries." J. E. LIARDET and T. DONNITHORNE. Dated October 19. 4d. Has for its object improvements in secondary batteries and in the manufacture of the same for storing electrical energy, and consists in part of improvements on and additions to the invention described in the specification of the patent applied for on the 9th January, 1882, No. 120.

5014. "Regulating electric currents and electromotive force, &c." L. CAMPBELL. Dated October 21. 4d. In a dynamo or magneto-electric machine, the contact-pieces of the commutator are not all at the same electrical potential, and in practice the brushes or collectors of these machines are placed so as to make contact with the commutator at the points of highest and lowest potential. As the current and electromotive force in a conductor are both proportional to the difference of the electrical potentials at its ends, it is evident that if one or both of the brushes of these machines be shifted so as to make contact with the commutator at any other point or points, there will be a corresponding change in the effects produced by these machines. In the present invention this principle is made use of by having one or more of the brushes movable or adjustable to any part of the commutator, automatically or otherwise.

5015. "Electro-magnetic and magneto-electric engines." C. F. VARLEY. Dated October 21. 2d. Has for its object improvements in electro-magnetic and magneto-electric engines. A hollow iron cylinder free to move has another cylinder inside it. They are united together or worked out of the solid. This compound cylinder is mounted so as to rotate upon its axis. Magnetism is imparted to it by an arrangement of magnets or a hollow helix surrounding it so that the double cylinder forms one of the poles of the magnet. In between these two cylinders is placed another magnetic cylinder which may be stationary or made to rotate. This cylinder is wrapped with wire parallel to its axis. This cylinder forms the other pole of the magnet. It is preferred to construct the cylinder or piece which goes between the inner and the outer cylinders of such a form that its section is like a section of half a double convex lens. The adjacent internal surfaces of the compound cylinder are curved in a corresponding manner. (*Provisional only.*)

5016. "Electro-magnetic and magneto-electric engines." C. F. VARLEY. Dated October 21. 2d. The invention is designed for the production of rotary motion from electric currents or electric currents from rotary motion, and for getting rid of or greatly reducing the burning at the places of contact. (*Provisional only.*)

5017. "Electro-magnetic and magneto-electric engines." C. F. VARLEY. Dated October 21. 2d. The object of the invention is to get a conductor moving between the poles of magnets so as to generate currents of electricity. (*Provisional only.*)

PROCEEDINGS OF SOCIETIES.

Physical Society.

Prof. CLIFTON in the Chair.

DR. OBACH described "An improved construction of the movable coil galvanometer for determining currents and E.M.F. in absolute measure." This is a more sensitive, accurate, and powerful instrument than the old form. It is intended for accurate measurements and testing other instruments. The needle of the new form does not dip, and its vibrations are rendered deadbeat by an air chamber. The secants of the inclination of the core are the multipliers of the tangents of the deflections. The coil consists of a single solid rod or band of copper for measuring powerful currents; and on the same ring is a fine coil of German silver wire for measuring E.M.F. No shunt is required owing to the movability of the coil. Dr. OBACH gave figures showing the accuracy of the apparatus, which is very great.

Profs. AYRTON and PERRY read a paper on the "Electric Resistance of Water," being the results of some experiments made by them some time ago. A comparison of the galvanometer and electrometer methods of measuring this resistance was made during the experiments, the results being in favour of the latter, especially with currents of less than six volts. When the electrodes or platinum plates in the water were end-on, the resistance was less than when face to face.

Mr. BOYS thought this curious result might be due to the resistance between the surface of the plates and the water being reduced.

In answer to Dr. COFFIN,

Prof. AYRTON stated that the plates were heated between every two experiments in the blow-pipe.

Prof. G. GUTHRIE remarked that Kohlrausch had found ordinary distilled water to be much more conductive than pure distilled water, which was an insulator, and inquired if Prof. Ayrton chose pure water.

The latter replied that his experiments were to test the merits of the galvanometer and electrometer modes of testing.

Prof. JONES stated that he found it best to use alternating currents for measuring the liquid resistance of cells, and described a mercury commutator for rapidly reversing the testing current.

Prof. AYRTON then described a lecture apparatus for showing the laws of centrifugal force. A rapidly rotated arm carrying a movable weight springs from the centre of an aneroid chamber filled with mercury. This chamber is on the rotating axle, and as the centrifugal force of the arm pulls out the diaphragm the mercury falls in the chamber and in a tube opening from it.

Prof. GUTHRIE remarked that the apparatus would serve as a speed counter.

Prof. PERRY then read a paper on the kinetic energy of rotating bodies, in which he pointed out the practical drawbacks to the "moment of inertia" calculations and suggested the use of a new constant (termed for the nonce the "M"). This is the amount of kinetic energy possessed by a rotating body when making one revolution per minute. To find the energy for N revolutions per minute multiply this by N^2. In the same way the "M" of a machine can be found and used.

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CORRESPONDENCE.

Atlantic Submarine Telegraphy.

I take the liberty to bring to your notice a copy (enclosed), of an article in reference to the origin of Atlantic telegraphy, which appeared in the Montreal (Canada) *Shareholder* of the 18th May. Perhaps you will deem it of sufficient interest and importance to warrant its reproduction in the columns of your widely-read journal.

D.

[The article referred to by our correspondent will be found in our other columns.—EDS. ELEC. REV.]

Sounds Caused by Electricity.

I herein enclose a description (taken from the *Mechanics' Magazine* of an early experiment made by Mr. Sellier in connection with sounds caused by electricity which, though rather old, seems not to be without some interest, in the hope that you may think it worth republishing in your valuable Review.

"M. Sellier has found it sufficient to place an electric diamond upon a pane of glass in order to produce sounds. When a well-polished sewing needle, suspended from a hair, is placed in a glass bowl filled with an acid sulphate of copper, the bowl crackles, even after the needle has been withdrawn and the liquid poured out. Small currents of common electricity become perceptible to the ear by means of wheaten straw struck upon a drum of vegetable paper."*

A. E. Conti.

London, *June 11th*, 1883.

Transformation of Electric Currents in Secondary Generators.

To measure the loss incurred in the transformation of electric energy in induction coils or secondary generators, I employed a very simple and what to me was the only means available at the date of my researches on secondary currents. The results are almost accurate, and may be taken as fairly representing what may be obtained in practice.

Remarkable as it may appear, these experiments and figures show that there is very little loss in the transformation, when certain forms of apparatus are used to effect the transformation. My first experiments were carried on by means of ordinary induction coils, using intermittent currents in the usual way, with an ordinary magnetic contact-breaker. The results were not very trustworthy, but invariably showed a great loss of energy in the transformation—something like 50 per cent. of loss. Later on I adopted the following system of generating secondary currents, which lends itself readily to accurate measurement, and which, after many experiments with various induction apparatus, proved to be the most efficient in my hands. I also used an apparatus for transforming electric currents, which is described in my patent specification, No. 4,752, 1882. I shall not refer to that in this paper, but may at a future time give some details regarding its performance.

For experiments and measurements referred to here the secondary generator used was an ordinary Gramme ring armature, with 60 sections of No. 14 B.W.G. cotton-covered copper wire, the core of No. 16 B.W.G. soft iron wire, forming a ring when complete of about 3 in. broad and 18 in. diameter. Thirty sections of the copper wire were taken as the secondary circuit and thirty as the primary, and so coupled up that a secondary section and a primary section followed each other alternately round the ring, as shown clearly in fig. 1, where B is the ring, A B are the terminals of the primary wire, and C D, the terminals of the secondary.

Both wires, secondary and primary, were thus precisely similar in resistance and in length; and were thus also similarly positioned on

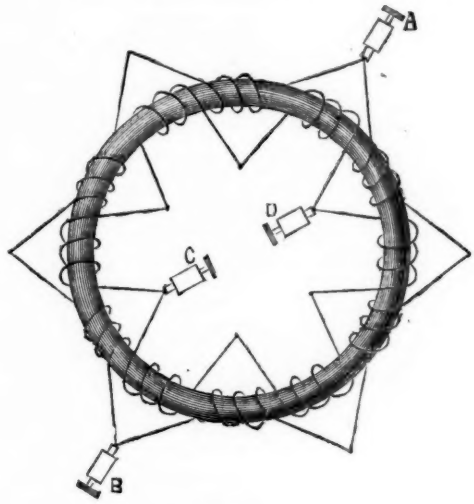

FIG. 1.

similar cores, so that indifferently either could be used as primary or secondary; this being so the difference in ampères between the primary and secondary currents would evidently be equal to the loss of energy taking place in the transformation.

Thus the use of a Gramme ring with so many sections enabled me to obviate the difficulties attendant upon the measurements in connection with alternating currents, as by placing a Siemens electric dynamometer in each circuit I could observe the current in ampères

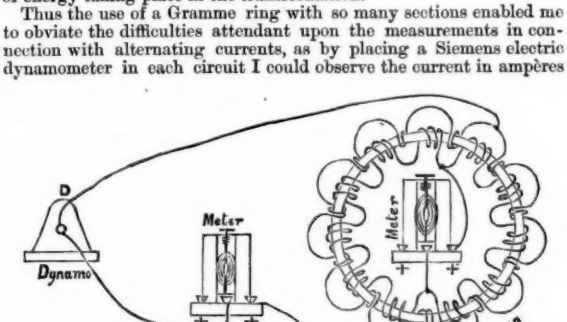

FIG. 2.

in the primary and secondary circuits. Fig. 2 shows the arrangement finally adopted. A small Kennedy alternating current dynamo was used to furnish the alternating primary current.

The resistance of the primary wire and dynamometer = 0·3 ohms. The secondary wire the same. The currents as measured in two of the experiments may be taken as the means of many; first we got in the primary a current of 12·78 ampères, in the secondary a current of 12·00 ampères, a difference of only ·78 ampères, or, in other words, a loss of only 6·1 per cent.

(Second) Current in primary	13·86 ampères.
,, ,, secondary	12·97 ,,
Loss	·89
Loss per cent. ..	6·42

The current in the secondary flowed through the secondary wire and the dynamometer only.

These results show a remarkably high efficiency for the Gramme ring used in this way as a secondary generator.

In conclusion, I may mention that the current in the primary when the secondary circuit was broken, was in the first instance 9·03 ampères, and it rose to 12·78 ampères on joining up the secondary; in the second instance it rose from 9·5 to 13·86 ampères on joining up the secondary.

The secondary and primary sections of the Gramme ring may be coupled up all in series or all in parallel arc to suit the currents required, but for measuring it is simpler to use them coupled, as indicated here.

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* See *Athenæum*, May, 1838.